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GOODWIN'S MODEL MONOPLANE EXHIBITED AT OLYMPIA

This kite-shaped double-surface monoplane has its motor between the surfaces. The propeller turns in a slit as shown.

## Third International Aero Exhibition at Olympia, 1911*

THE EXHIBITS ANALYZED

The Olympia Aero Show has unquestionably realized all anticipations of exceptional interest. It is true that the exhibits might have been more numerous; but there were, after all, twenty different machines on view, ten of which were monoplanes and ten biplanes—which fact in itself is additionally interesting, as indicating the balance of opinion that exists at the present time as to the relative merits of the two types. Each type has, of course, its own particular advantages, which are emphasized or deprecated by individual designers according to their own personal view of what problems are most in need of immediate solution.

At the present show the keynote in design is struck by the prevalence of inclosed bodies, a feature that characterizes the majority of the machines present, and is of itself of the greatest interest and importance. At one time constructors used to be very particular about adopting stream-line form for struts and other small members; but practical considerations soon showed that this refinement scarcely warranted—by any increase in efficiency that it afforded—more attention than could be conveniently bestowed upon it in the ordinary course of construction. If struts and spars could conveniently be made of stream-line form without undue extra expense, all well and good; if,

* Reprinted from *Flight*.

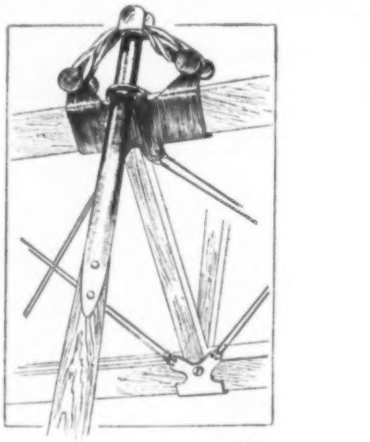
A COMBINED SUBMARINE AND MONOPLANE

This freak model gives an interesting hint of what the future aeroplanes may accomplish.

The Valkyrie monoplane in the center foreground. The cigar-shaped Piggott monoplane is at the right in the middle distance. Capt. Cody's huge biplane is shown at the extreme right.

GENERAL VIEW OF THE AERO AND MOTOR EXHIBITION AT OLYMPIA

on the other hand, it was more convenient to make them rectangular, then some leading firms, at least, made no bones about ignoring the purely scientific side of the problem. As a matter of fact, moreover, this elaborate application of pure theory to practice is very apt to ignore practical considerations that are not taken into account in the theoretical hypothesis.



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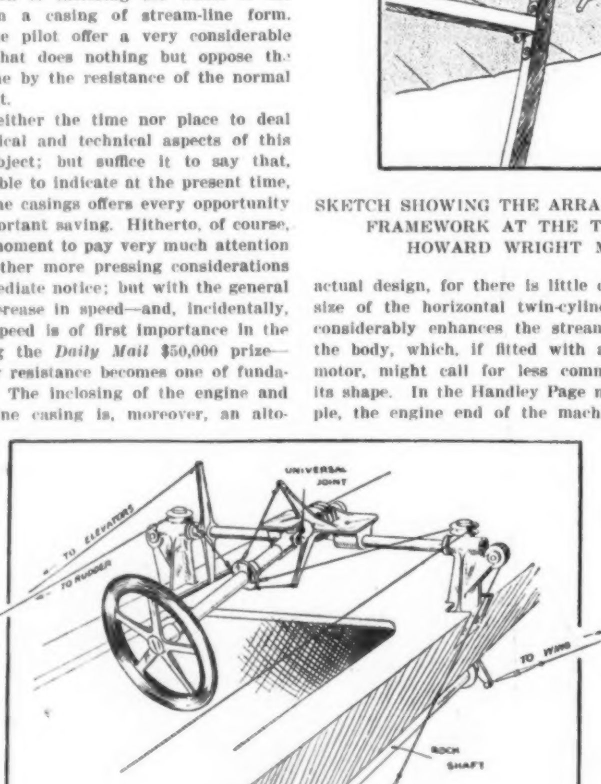
SKETCH ILLUSTRATING THE CRUTCH SUSPENSION OF THE BRISTOL MONOPLANE

For instance, aeroplanes nowadays no longer only fly in the calm; and, indeed, the art of aviation has progressed to an extent sufficient to enable pilots to navigate the atmosphere when the wind is blowing at a velocity that represents, numerically, a fairly high percentage of their own flight speeds. If, therefore, the wind is not blowing in the line of flight, the axes of stream-line forms on the machine will be more or less athwart the relative wind, and much of the advantage of the special shape will thus be set at nought. While this argument holds good in connection with the struts and other members that are relatively small compared with the machine as a whole, it does not necessarily apply with equal force to the question of inclosing the whole of the principal masses in a casing of stream-line form. The engine and the pilot offer a very considerable extent of surface that does nothing but oppose the flight of the machine by the resistance of the normal air pressure upon it.

Clearly this is neither the time nor place to deal with the mathematical and technical aspects of this most important subject; but suffice it to say that, as far as theory is able to indicate at the present time, the use of stream-line casings offers every opportunity for effecting an important saving. Hitherto, of course, it has been of less moment to pay very much attention to this matter, as other more pressing considerations have called for immediate notice; but with the general tendency toward increase in speed—and, incidentally, the fact that high speed is of first importance in the prospect of winning the *Daily Mail* $50,000 prize—the question of body resistance becomes one of fundamental importance. The inclosing of the engine and pilot in a stream-line casing is, moreover, an altogether different matter from the mere shaping of individual struts.

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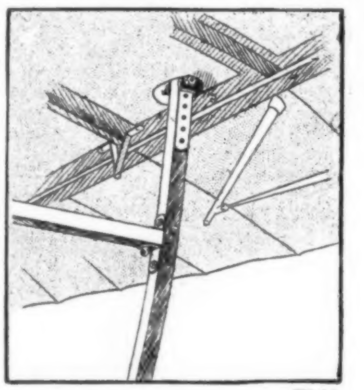
SKETCH ILLUSTRATING THE CONTROL ON THE BLACKBURN MONOPLANE

At Olympia this year, then, stream-line bodies are the predominating feature in design. In the degrees of completeness they range all the way from the new Piggott monoplane, which has every part of the body, the engine, pilot and passenger, completely inclosed in a large torpedo-shaped casing with a hemispherical head. This represents the extreme development of the stream-line idea, and it will be interesting to watch how far this whole-hearted adoption of a good principle works out in practice. Generally speaking such things are best evolved by degrees, and we do not doubt that it will be necessary to cut a few more holes in the Piggott shell before it satisfies the requirements of the average pilot. It will, at any rate, take, we should imagine, some little time to get used to being completely boxed in, for even as it is, with orthodox machines, aviators often complain of impeded vision. On the Piggott machine the outlook is entirely through windows made of insoluble gelatine, and the passenger and the engine are both situated in front of the pilot. The propeller boss, which is conical, forms a revolving pointed nose on the otherwise hemispherical head of the body.

An almost equally pronounced example of inclosed body-work is given by the Kny aeroplane, constructed by Messrs. Mulliner of London and Northampton, but in this machine the body is boat-like in form, and the pilot and passenger can have, at any rate, nothing but sky above them, if they care to detach the conning tower cover plate. Like the Piggott, the stream-line body of the Kny aeroplane extends to the tail, and the latter part of it is fabric-covered. In front, the outer surfacing material is sheet aluminium. On the Piggott machine, the surfacing material is entirely fabric. Fabric is also used for enclosing the framework of the Nieuport monoplane, for which Maurice Ducrocq has the agency. In this machine, however, the rectangular section of the main frame has not been inclosed by any supplementary casing, as on the Piggott monoplane, and consequently the sides of the body are flat. In appearance, however, the Nieuport monoplane distinctly belongs to the class under consideration, although possibly its right to such classification is based more on appearance than



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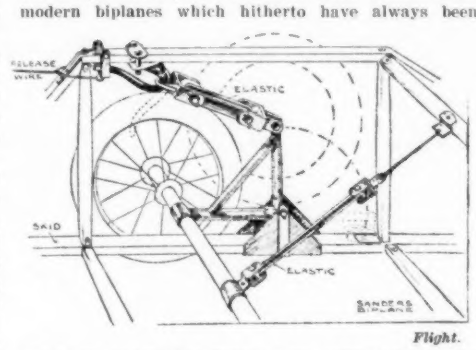
SKETCH SHOWING THE ARRANGEMENT OF THE FRAMEWORK AT THE TAIL OF THE HOWARD WRIGHT MACHINE

actual design, for there is little doubt that the small size of the horizontal twin-cylinder engine in front considerably enhances the stream-line appearance of the body, which, if fitted with a more conventional motor, might call for less comment, on account of its shape. In the Handley Page monoplane, for example, the engine end of the machine is anything but stream-line like in form, yet there is no better example of stream-line construction at the Show than is provided by the after-part of its body. It has quite a fish-like appearance, and is surfaced throughout in highly-polished three-ply mahogany. As the machine is only designed to carry the pilot, its general lines are characterized by short overall length, and so this particular machine has an uncommonly neat appearance.

More conventional examples of inclosed body-work, in which the surface material is merely laid straight on the frame and forms flat sides, are to be seen in the Blériot, Martin-Handasyde, Bristol and Blackburn monoplanes, and, strictly speaking, it is to this latter category that the Nieuport also belongs.

The most interesting development of inclosed body-work is, however, in connection with some of the modern biplanes which hitherto have always been

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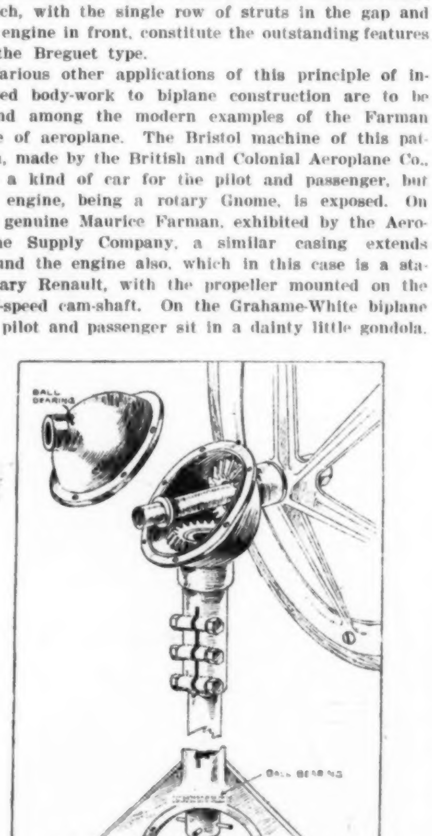
SKETCH ILLUSTRATING THE MECHANISM OF THE DISAPPEARING AXLE ON THE SANDERS BIPLANE

By releasing a catch the axle and wheels are drawn above the level of the skids, on which latter members the machine can therefore land direct.

characterized by the entire exposure of all the principal masses. The most important—as it was also one of the earliest examples of this system of construction—is the Breguet biplane, which may be described as having a monoplane body supporting biplane wings. The body is completely surfaced from head to tail, and is of great length. Unfortunately it has a most ungainly appearance, owing to a peculiar discontinuity in its lines; but this is, perhaps, more pronounced when the pilot is not on board, because the general shape has been based on the aviator's position in the machine and on the amount that his body projects above the level of the frame. A new type of Bristol biplane, which is now being built in addition to the Farman pattern, is designed on Breguet lines, and has the characteristic inclosed body, which, with the single row of struts in the gap and the engine in front, constitute the outstanding features of the Breguet type.

Various other applications of this principle of inclosed body-work to biplane construction are to be found among the modern examples of the Farman type of aeroplane. The Bristol machine of this pattern, made by the British and Colonial Aeroplane Co., has a kind of car for the pilot and passenger, but the engine, being a rotary Gnome, is exposed. On the genuine Maurice Farman, exhibited by the Aeroplane Supply Company, a similar casing extends around the engine also, which in this case is a stationary Renault, with the propeller mounted on the half-speed cam-shaft. On the Grahame-White biplane the pilot and passenger sit in a dainty little gondola.

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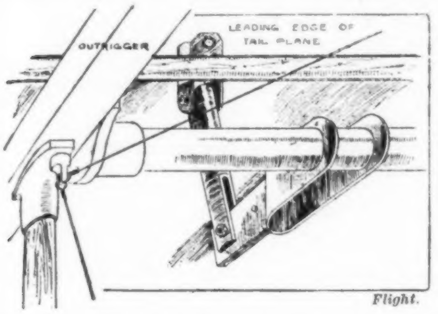
THE MARTIN-HANDASYDE CONTROL GEAR

On the Howard Wright the outrigger carrying the foot-rest is covered in underneath, and forms a kind of tray, but otherwise everything is exposed as in the original design.

Turning to a consideration of the machines at

Olympia from the point of view of their general design, it is interesting to compare them by classification into broader and somewhat more fundamental divisions than results from a mere discussion as to whether they are in the latest mode as regards body construction. There are twenty machines on view, ten of which are biplanes and ten monoplanes. Of the ten biplanes, five may properly be classified as belonging to the Farman type. These include the British-built copies by the British and Colonial Aeroplane Company, Messrs. Howard Wright and Messrs. Grahame-White. Each has minor peculiarities of its




SKETCH ILLUSTRATING HOW THE ATTITUDE OF THE TAIL IS ADJUSTED BY A HAND WHEEL ON THE SOMMER-TYPE HUMBER BIPLANE

own. There is also the Maurice Farman, which differs from the Henry Farman in the flatter appearance of its planes and in the extended skids, which curve up to support the elevator on the Sommer principle. The Sommer type, which may be practically considered as a modification of the Farman design, is represented at Olympia by the Humber biplane. The essential characteristics of the Farman machine, which is unquestionably the most popular aeroplane that has yet been built, are basically that of the original Voisin, from which it was evolved by Henry Farman, who flew the Voisin biplane at a time when he was one of the first men to fly at all. The Farman machine is a biplane with an elevator in front, a tail behind, and the propeller immediately behind the main planes. As the popular type of engine used on this machine is the Gnome rotary, which is always mounted adjacent to the propeller, the principal mass is situated aft of the center of pressure, and consequently the tail is necessarily of the lifting type because the pilot does not, in the accepted position, balance the engine by his own weight.

On the Breguet biplane, where the relative positions of the engine and pilot are reversed, the tail becomes, practically speaking, a non-lifting member, although in actual practice the tail of the Breguet is a slightly cambered plane. Incidentally, of course, the Breguet system facilitates the use of a monoplane type body, because the propeller, being in front, does not interfere with the continuity of the longitudinal spars in the construction of such a member. The inclosing of the body so as to be more or less of stream-like form, which feature has already been discussed, is, of course, only a natural evolution as the outcome of taking a further step in detail design. While on the subject of the Breguet machine it should also be mentioned that quite apart from the question of type this model belongs to a class apart in any case, because it is constructed entirely of steel—timber being now, as formerly, the standard material for aeroplane framework. The Breguet-type aeroplane made by the British and Colonial Aeroplane Company is constructed of wood.

Of the three remaining biplanes at Olympia, each belongs to a separate class. There is the small Wright racer, with which type Mr. Alec Ogilvie competed in the Gordon-Bennett race; the Cody biplane, with which Mr. S. F. Cody won the British Michelin Cup; and the Sanders biplane, which, in some essential features, resembles the biplane originally designed by Messrs. Short Brothers.

The Wright biplane in its present form is characterized by the absence of any front elevator, and by the use of a non-lifting tail. Practically, the machine is in balance about the center of pressure with the pilot on board, and, indeed, the spiral draught from the propellers is enough to upset this balance through its influence on the tail plane.

The Cody biplane is similarly a balanced machine, but it differs from the present Wright type in having an elevator. The elevator on the Cody machine is a cambered plane, and normally carries some of the load for convenience in control, although it is not essential from constructional considerations that it should do so. The engine on the Cody biplane is carried on the lower plane, and, within reason, both it and the pilot can have their positions altered in order to effect any degree of balance that may be required. In practice, as has been mentioned, Mr. Cody prefers that the elevator should be loaded a little, as he considers that it facilitates control.

The Sanders aeroplane is fundamentally a modification of the original Wright biplane, as its only tail member is the rudder, and there is an elevator in front. This elevator, however, probably carries proportionately more load than on the original Wright, because the very strong Short type girder undercarriage is probably heavier than the corresponding outrigger on the original Wright machine. These girder skids and the elevator shaft itself are, to all intents and purposes, the same as those on the Short biplane last year. The main planes themselves are characterized by sharply down-turned extremities on the upper plane that act as side curtains to prevent leakage and sideslip. The engine and propeller on the Sanders biplane are arranged more or less on the same lines as the Cody—that is to say, the propeller is mounted midway in the gap and is driven at half engine speed by a single vertical chain. The rudder is a triplane, in which respect it differs from the biplane rudder on the Wright.

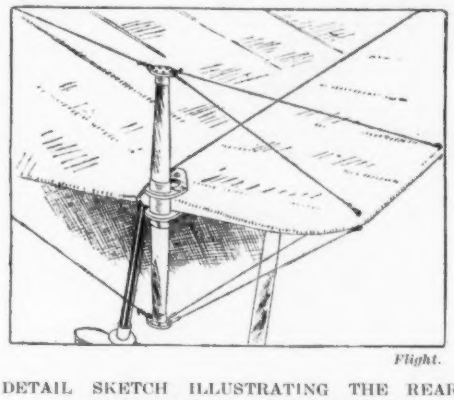
If we attempt to compare the monoplanes on a similar basis it is somewhat more difficult to differentiate between types, owing mainly to the gradual merging of the characteristics of the Blériot and Antoinette patterns that have hitherto led the field and been distinct. Thus, for instance, the V-section boatlike Antoinette body may be seen combined with Blériot pattern wings, which are certainly quite distinct from the planes of the true Antoinette, both on account of the fact that they are thinner and also by reason of the absence of individual trussing on the wing spars.

A genuine Blériot, with its characteristic lifting tail, rectangular open girder body and rather low set center of gravity, is exhibited by the London representatives of that firm; while the Martin-Handasyde monoplane may be considered, at any rate as regards its appearance, as characteristic of the real Antoinette. It has the triangular section covered frame, non-lifting tail and individually trussed wing spars. As a design, however, the Martin-Handasyde monoplane is full of original detail.

Machines like the Blackburn and Bristol monoplanes may be classified as lying between these two distinct types, inasmuch as they have Antoinette bodies with wings that certainly bear more resemblance to the Blériot pattern than the Antoinette, and are, at any rate, trussed only to one central mast.

In the Kny, Piggott, Handley Page and Nieuport monoplanes the body form predominates over all other characteristics, but in the principle of the non-lifting tail they are alike. The Kny has its wing spars individually trussed more or less on the Antoinette principle, but in the other machines mentioned the wing spars are not thus reinforced.

Properly speaking, the real distinction in monoplanes of this classification should be drawn between the tail behind and tail first types, and in the latter category the Valkyrie is at present the only example on view. This machine is of essentially British design and construction. It is characterized by a fixed load-

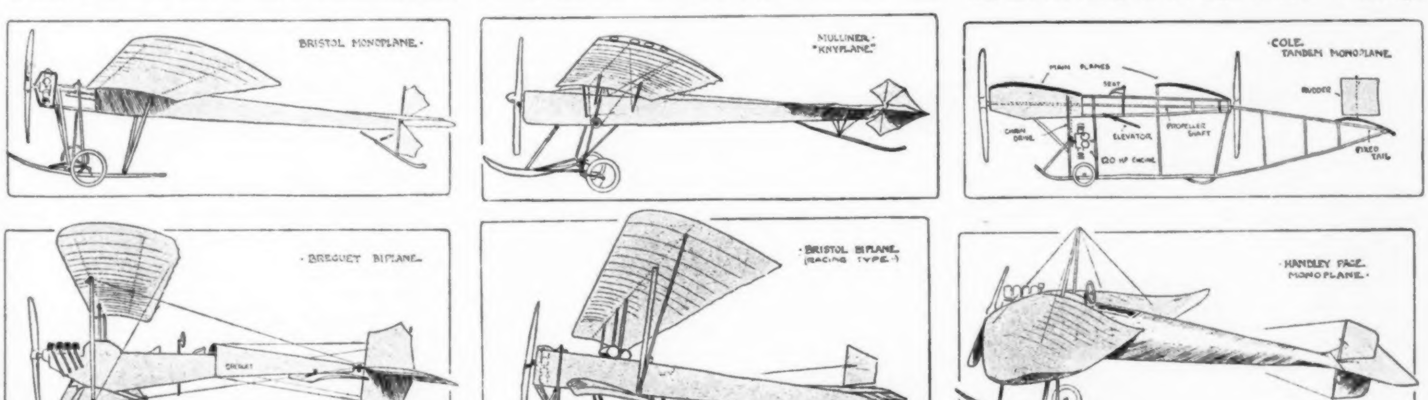



DETAIL SKETCH ILLUSTRATING THE REAR ELEVATING PLANE ON THE FARMAN BIPLANE.

carrying leading plane in front of the main plane, which leading plane must not be confused with the movable elevator that is also provided. In the Valkyrie machines the propeller, engine and pilot are likewise all in front of the main plane. In the Antoinette monoplane the engine and propeller are both appreciably in front of the main plane, and on the Blériot monoplane the engine and propeller are still in front, but distinctly closer to the leading edge. Inasmuch as the central portion of the Valkyrie main plane is recessed to take the propeller, the engine—supposing it to be a Gnome rotary—is not really so much further forward of the leading edge proper than it is on the Antoinette, and thus the essential distinction is more or less confined to the change in the position of the pilot. Appearances are therefore apt to be a little deceptive in respect to the relative distribution of weight with this particular design.

A monoplane that is altogether in a class by itself is the Dunne, which is, so far as practical flying machines are concerned, an evolution of the Dunne biplane. The biplane was in itself, however, originally evolved from still earlier monoplane models. A characteristic feature of this machine is the absence of a tail and the V-plan form of the wings, which also have a varying angle of incidence from root to tip. The object of the design is the acquisition of natural stability, and the purpose of sloping back the wings is to acquire an overall length for the machine as distinct from the chord dimension. This increment in length virtually introduces the principle of a tail, and the change in the angle of incidence throughout the succeeding sections of the wings confers the principle of the dihedral angle on the relative attitude of the virtual tail portion in respect to the central leading portion of the machine.

In fundamental principle the Valkyrie appears to be not dissimilar to the Dunne, although there is no structural likeness whatever. The leading plane in the Valkyrie, however, may be likened to the central portion of the Dunne machine, and it makes a dihedral angle in respect to the main plane, the extremities of which correspond to the rearward tips of the Dunne wings. This comparison is, perhaps, not altogether




VARIOUS TYPES EXHIBITED AT OLYMPIA

Drawings reproduced from *Flight*.

conclusive as thus briefly drawn, but it has been made with the object of emphasizing that it is in the underlying principle rather than in the form of the machine that types should be compared on a common scientific basis. The Handley Page monoplane, for example has the sloped back wings arranged with a crescent plan form of leading edge, and the dihedral angle is present in a minor degree by the use of upturned flexible wing tips. Apart from the shape of its wings, however, the Dunne monoplane is characterized by its underhung load, the engine and pilot being situated beneath the wings. In the Sanders biplane, which in this respect represents the principle of the early Wright flyer, the elevator may be regarded as a forward tail; but as its attitude can be varied at will, stability is dependent on the action of the pilot.

Thus far we have discussed the machines that are already familiar to readers of *Flight*, and indeed it is one of the most satisfactory features of the present exhibition that so much of the display is admittedly within the realm of successful practice. No one can possibly say that the present exhibition lacks originality in aeroplane design, and yet it is singularly free from freaks. Practically the only purely speculative designs are the tandem monoplane exhibited by Messrs. William Cole, and the machine exhibited by Mr. F. L. Bartelt. Of these the former is unfinished, and is thus possibly in some degree exempt from criticism, so we would therefore confine ourselves to saying that it labors under the disadvantage of having an unprepossessing appearance. The design is due to a Frenchman, M. Magnodex, and attacks a particularly interesting problem in aeroplane construction. The tandem monoplane was on the point of being the first machine to fly in America when Langley was tripped up by ill-fortune in his endeavor to demonstrate a full-sized machine of this type before representatives of the American Government. Langley had succeeded in obtaining very successful flights with large power-driven models, and his construction of a man-carrying aeroplane was undertaken at the instigation of the American Government, as a direct outcome of his previous work. Faulty launching ways twice brought about temporary disaster to the machine, and the authorities, having little faith in those days, withdrew their support. Within a few weeks the Wright Brothers had secretly succeeded where Langley failed, and in the evolution of their machine the tandem monoplane has been forgotten.

The necessity for overall length on a machine as a factor in its stability, and the necessity for providing an adequate body in order to carry the tail, certainly suggest the possibility of developing a useful type in the tandem monoplane, since it plausibly offers an opportunity to provide twice the lifting surface for the extra weight of a pair of wings. Whether or no the Cole machine will succeed as the modern prototype of this class we should not like to say. In its present form it certainly seems to us to be following an undesirable principle in attempting to combine such unknown quantities as a tandem monoplane, wooden folding wings, twin propellers, and a new type of rotary engine on the same machine.

The Bartelt machine is something apart from all accepted types. It consists of a steel structure of biplane appearance with loose, saggy wing surfaces. The wings are mounted at their shoulders on cranks, whereby they rise and fall, while always remaining parallel to the ground. The motion of the cranks being circular, the wings, simultaneously with their rise and fall, move forwards and backwards—in other words, they perform a modified form of paddle action, the object being to derive support by beating the air. The wing motion is obtained from chain transmission, and in addition to the supporting reaction, there is said to be a propelling force sufficient to keep the machine going without the small propeller that is such a comparatively insignificant constructional feature of the machine as a whole. We are informed that the small scale prototype of the machine exhibited actually flew with a pilot weighing 8 stone 4 lbs.

# The Air-brake as Related to Progress in Locomotion—III*

## The History of a Great Invention

By Walter V. Turner, Chief Engineer, Westinghouse Air Brake Co., Pittsburg, Pa.

Continued from Supplement No. 1841, page 230

To consider for a moment the quantitative results of the improvements which have been mentioned as evidenced by the comparative stopping distances of trains equipped with the types of brakes referred to. The diagram (Fig. 18) shows concretely the relative efficiency of the various forms of brakes for passenger trains, the difference in the length of the lines corresponding approximately to the reduction of distance required in which to stop a given train of one locomotive and six cars from a speed of 60 miles per hour since the introduction of the air-brake. If the diagram were inverted so that it is viewed upside down, a fair idea will be obtained of what the relation between the stops would have been through the respective periods of train development had there been no change in the air-brake since first applied.

The tendency of modern rolling stock to lower brake efficiency is further illustrated in Fig. 19. The retardation curves show the stopping distance from about the same initial speed of a train composed of cars weighing 30,000 pounds and braking at 83 per cent, and a train of 84,000 pound cars braking at 150 per cent. It will be seen that notwithstanding the 60 per cent greater braking power of the heavier train, the difference in stop is not greatly in its favor. The reason for this is clear when it is considered that the work done during the stop for the light train was 14.5 foot-tons per brake-shoe per second while with the heavy train it was 29 foot-tons per brake-shoe per second, which shows that under modern conditions each brake-shoe is doing about twice the amount of work required formerly in order to make approximately the same stop, which consequently lowered the coefficient of friction and thus tended to equalize the actual retarding forces developed in the two cases.

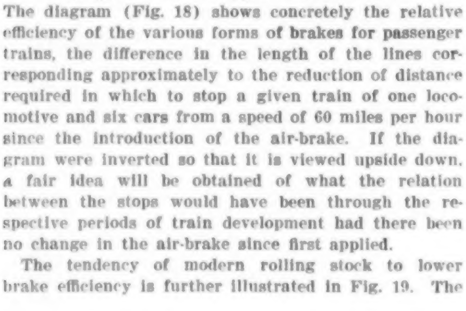



Fig. 18.—Diagram of Development of Air-brake Efficiency Since 1869

The diagram below the comparative curves shows, first, the length of stop for light train with the equipment of its day; second, what the stop would have been with the heavier train had there been no change in brake equipment to correspond to the increased weight of train; third, what braking power was actually required to stop the heavy train in the distance the light train was stopped with its brake equipment; and fourth, what the stop of the light train would be if it were possible to apply to it the brake equipment required for the heavy train. This is a significant and all-sufficient example of what is required to meet modern conditions as effectively as they were provided for in the past.

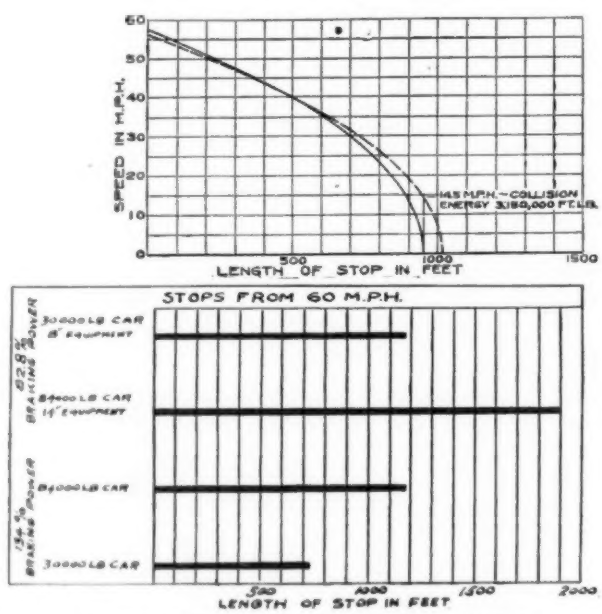



Fig. 19.—Comparative Retardation Curves and Braking Power Chart for Trains of 1875 and 1907

| Date | Speed in M.P.H. | Lgth. of stop in feet | Time of stop in sec. | Wght. of trains, tons | Work in ft.-tons performed by brakes: Total | Per sec. | Per brake-shoe per sec. | B. P. p. c. |
|---|---|---|---|---|---|---|---|---|
| 1875 | 56.0 | 1030 | 22.0 | 227 | 23900 | 1086.4 | 14.70 | 82.8 |
| 1907 | 57.3 | 954 | 18.7 | 550 | 61300 | 3278.0 | 28.75 | 150.0 |

Dotted curve shows stop on Midland Railway, 1875, with the Westinghouse Automatic Brake.

Full line curve shows stop made on W. J. and S. R. R., 1907, with the Westinghouse "LN" Brake.

Had the braking power as shown in the last column of the table and represented by the full-line curve, been 134 per cent instead of 150 per cent, the two stops would have been the same.

### Control Valve Equipment.

With the introduction of heavy sleeping cars and passenger equipment cars carrying heavy motive power apparatus such as self-contained motor cars, not only were the factors above mentioned, which tend to lower brake efficiency, aggravated to a marked degree, but limiting conditions were encountered in other directions. The brake force required to control such heavy (135,000 to 170,000 pound) cars with approximately the same effectiveness obtainable with the apparatus used on lighter cars became so great as to exceed the capacity of a single brake-cylinder

* Presented at the meeting of the Mechanical and Engraving Section of the Franklin Institute.

even with the highest brake-cylinder pressure and greatest multiplication of its power by leverage that could be permitted.

The single brake-cylinder had already reached a maximum of 18 inches in diameter, and it was generally agreed that a larger size brake-cylinder would be impracticable from a manufacturing, operative and maintenance standpoint.

With 100 to 105 pounds brake-cylinder pressure being obtained from 110 pounds brake-pipe pressure carried there was little hope of raising the cylinder pressure higher, and no materal or permanent improvement in the general condition would result even if the full 110 pounds could be realized in the brake-cylinders.

There was no suggestion of an increase in brake-pipe pressure above the present standard, it being universally recognized that 110 pounds was about as high as could safely and economically be used with the type of apparatus and fixtures in general service.

The multiplication of the brake-cylinder pressure through the leverage of the foundation brake rigging had been carried, in many cases, beyond the recommended 9 to 1 maximum simply because it was the most obvious, simplest, and most convenient means of providing the heaviest cars with a proportionate braking power approaching that used on lighter cars. The evils of this expedient soon became manifest in dragging brake-shoes, "slow release" and trouble in keeping the brake rigging properly adjusted. Most important of all, from a safety standpoint, was the effect of this high leverage ratio in multiplying the losses due to lost motion in the rigging or truck members, brake-shoe movement and so on, the result of which was evidenced in excessive false piston travel and consequent failure to obtain the maximum brake-cylinder pressure contemplated in the design, or still more serious loss in braking power due to the piston traveling so far as to bottom on the cylinder head.

These and other mechanical limitations therefore barred further progress in this direction, and two alternatives remained, viz.:

1. To increase the effectiveness of the single brake-cylinder as far as possible by using two brake-shoes per wheel (clasp brake).

2. To use two brake-cylinders per car.

While the first of these alternatives would undoubtedly be of some assistance, there are objections to this design, not the least of which is a reasonable doubt whether the acknowledged theoretical advantages of the clasp brake would prove to be practicable; and a reasonable certainty that no matter to what extent its theoretical advantages might be realized in practice, the maximum increase in efficiency thus afforded could not be sufficient to meet the demands of conditions already existing, to say nothing of the possibilities of the future.

On the other hand, the two-brake-cylinder proposition did not necessarily involve any new or untried principles, since two complete equipments of the type already in service might be used, one for each end of the car. This would provide ample stopping power for existing conditions, and lend itself readily to extension, as still more severe demands might arise. It was therefore recognized that such an arrangement offered the best solution of the problem of the proper air-brake equipment for passenger cars weighing 130,000 pounds or over. Furthermore, it was seen that a single valve mechanism to control the admission of air to and release of air from the two-brake-cylinders would possess such marked advantages over a complete double equipment for each car as to make a satisfactory and practicable design of such a valve greatly to be desired. In reality, the success and scope of the two-cylinder arrangement depended wholly on the characteristics of the valve device adopted for this purpose.

It was but logical that, in the first practical solution of this problem, use was made of the same principles, both of construction and operation, as had been embodied in a valve device already in use for some years, and giving the best of satisfaction under conditions quite similar to those of the two-cylinder passenger-car equipment. While this valve (the distributing valve of the "ET" locomotive brake equipment) was particularly designed to operate in connection with two or more brake-cylinders on locomotives, its distinctive operative features were equally advantageous for passenger car service. Consequently, when the introduction of 85-ton multiple unit electric motor cars on the N. Y., N. H. & H. R. R. electric zone called for a correspondingly effective form of brake apparatus, of necessity using two-brake-cylinders, the valve mechanism adopted was a modification of the distributing valve type, the changes being only such as were required to adapt this device to passenger train service. From the start, its performance under the severe demands of suburban electric service was so satisfactory as to thoroughly establish the advantages of this type of equipment for the high braking efforts and large brake-cylinders required by the heavier classes of cars. It is hardly necessary, however, to go further into detail regarding its construction or operation, first, because the design of its operating mechanism resembles so closely that of the distributing valve, and, second, since it served to mark one stage only in the development of a distinct type of brake apparatus for such service.

As already stated, with the advent of passenger-carrying cars weighing from 135,000 to 150,000 pounds in steam road service and still heavier motor cars, carrying extraordinary dead weight loads, the limit of an efficient single-cylinder equipment was approached and in some cases exceeded. But this was only one phase of the situation. The demand of high speed heavy train service had steadily advanced to a point where, for adequate control, something more was required of a brake than merely maximum retarding power in emergency. The ordinary service functions and automatic safety and protective features became hardly secondary in importance. Briefly stated, the requirements recognized as essential in a satisfactory brake for this modern service are as follows:

1. Automatic in action.

2. Efficiency not materially affected by unequal piston travel or brake-cylinder leakage.

3. Prompt serial service action.

4. Graduated release.

5. Quick recharge and consequent ready response of brakes to any brake-pipe reduction made at any time.

6. Predetermined and fixed flexibility for service operation.

7. Full emergency pressure obtainable at any time after a service application.

8. Full emergency pressure applied automatically after any predetermined brake-pipe reduction has been made after equalization.

9. Emergency braking power approximately 100 per cent greater than the maximum obtainable in service applications.

10. Maximum brake-cylinder pressure obtained in the least possible time.

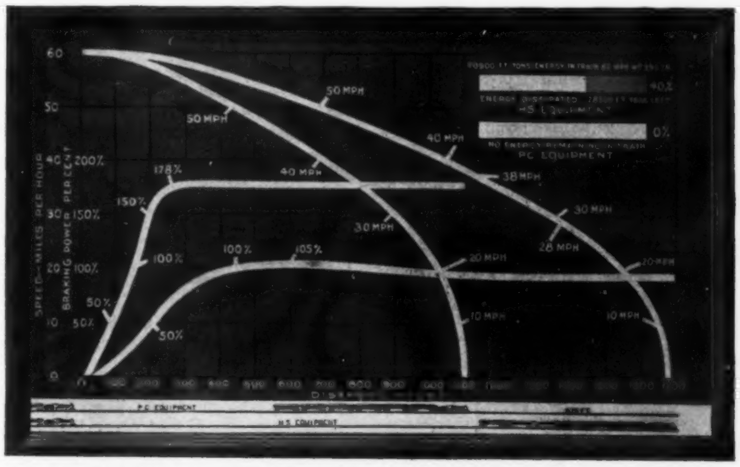



FIG. 21.—COMPARATIVE TRAIN STOPS, CONTROL VALVE AND HIGH-SPEED BRAKE EQUIPMENT

11. Maximum brake-cylinder pressure maintained throughout the stop.

12. Brake rigging designed for maximum efficiency.

13. Adaptability to all classes and conditions of service.

That certain of these requirements demanded radical changes in the valve device used on the car is evident from a comparison with the functions of the previous types already referred to, since but one of these required functions was contained in the older equipment. These considerations led to the latest development in the art of controlling heavy, high-speed passenger trains, employing what is known as a control valve in the place of a triple valve, the functions of which have already been mentioned in brief. The complete equipment is known as the schedule "PC," and is illustrated in Fig. 20.

The relative stopping power of the most efficient of the old order of brake apparatus—the high-speed brake—and of the control valve apparatus, is contrasted in the curves of Fig. 21. Both the comparative lengths of stop and the relative rates of rise and amount of maximum braking power are shown by the curves. It will be noted that the 575 foot shorter stop made with the "PC" equipment resulted not only from the higher braking power utilized, but also from the quicker rate at which this braking power was built up to its maximum value. As a result you will note that the speed of the high-speed equipment train when passing the point (1,100-foot stake) at which the "PC" equipment train stopped, was still as high as 38 miles per hour, which means that 40 per cent of its initial kinetic energy (at 60 miles per hour) still remained to be dissipated (harmlessly in this case, fortunately) before the train could be stopped.

Moreover, not only was this speed 38 miles per hour in the case of the high-speed equipment train, but it passed the 1,100-foot stake six seconds before the "PC" equipment train reached that point. That is to say, the train with the "PC" equipment came to a stop at the 1,100-foot stake six seconds after the train equipped with the high-speed equipment passed this

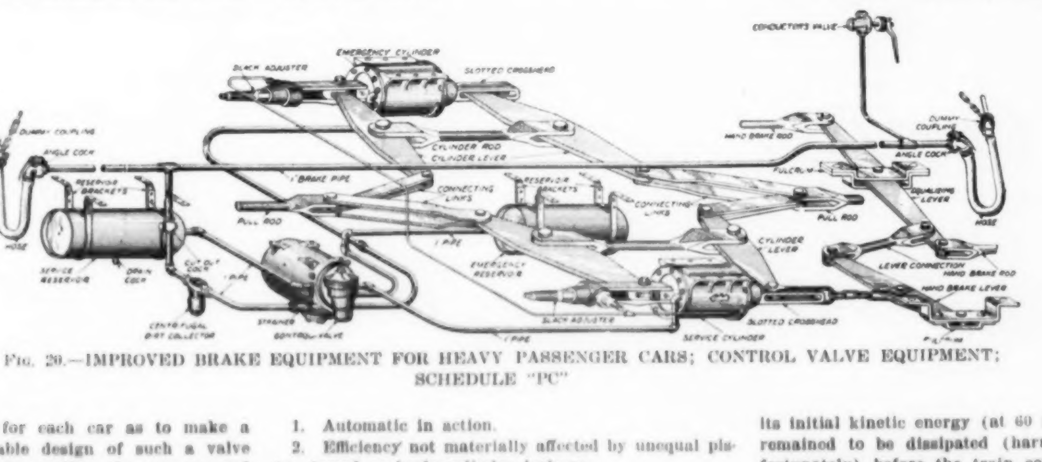
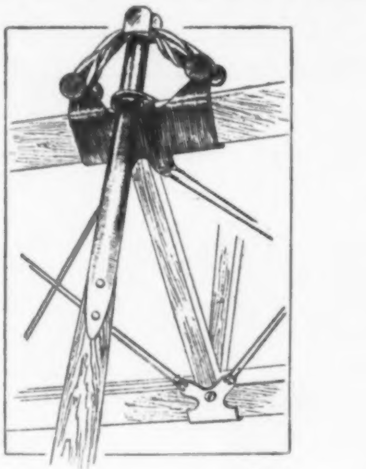



FIG. 20.—IMPROVED BRAKE EQUIPMENT FOR HEAVY PASSENGER CARS; CONTROL VALVE EQUIPMENT; SCHEDULE "PC"

on the other hand, it was more convenient to make them rectangular, then some leading firms, at least, made no bones about ignoring the purely scientific side of the problem. As a matter of fact, moreover, this elaborate application of pure theory to practice is very apt to ignore practical considerations that are not taken into account in the theoretical hypothesis.



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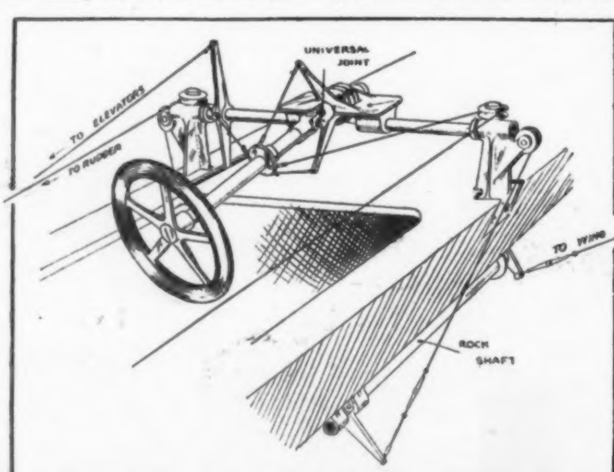
SKETCH ILLUSTRATING THE CRUTCH SUSPENSION OF THE BRISTOL MONOPLANE

For instance, aeroplanes nowadays no longer only fly in the calm; and, indeed, the art of aviation has progressed to an extent sufficient to enable pilots to navigate the atmosphere when the wind is blowing at a velocity that represents, numerically, a fairly high percentage of their own flight speeds. If, therefore, the wind is not blowing in the line of flight, the axes of stream-line forms on the machine will be more or less athwart the relative wind, and much of the advantage of the special shape will thus be set at nought. While this argument holds good in connection with the struts and other members that are relatively small compared with the machine as a whole, it does not necessarily apply with equal force to the question of inclosing the whole of the principal masses in a casing of stream-line form. The engine and the pilot offer a very considerable extent of surface that does nothing but oppose the flight of the machine by the resistance of the normal air pressure upon it.

Clearly this is neither the time nor place to deal with the mathematical and technical aspects of this most important subject; but suffice it to say that, as far as theory is able to indicate at the present time, the use of stream-line casings offers every opportunity for effecting an important saving. Hitherto, of course, it has been of less moment to pay very much attention to this matter, as other more pressing considerations have called for immediate notice; but with the general tendency toward increase in speed—and, incidentally, the fact that high speed is of first importance in the prospect of winning the *Daily Mail* $50,000 prize—the question of body resistance becomes one of fundamental importance. The inclosing of the engine and pilot in a stream-line casing is, moreover, an altogether different matter from the mere shaping of individual struts.

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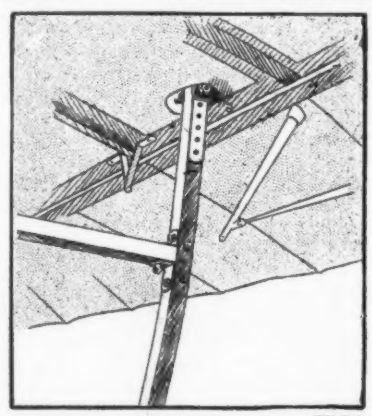
SKETCH ILLUSTRATING THE CONTROL ON THE BLACKBURN MONOPLANE

At Olympia this year, then, stream-line bodies are the predominating feature in design. In the degrees of completeness they range all the way from the new Piggott monoplane, which has every part of the body, the engine, pilot and passenger, completely inclosed in a large torpedo-shaped casing with a hemispherical head. This represents the extreme development of the stream-line idea, and it will be interesting to watch how far this whole-hearted adoption of a good principle works out in practice. Generally speaking such things are best evolved by degrees, and we do not doubt that it will be necessary to cut a few more holes in the Piggott shell before it satisfies the requirements of the average pilot. It will, at any rate, take, we should imagine, some little time to get used to being completely boxed in, for even as it is, with orthodox machines, aviators often complain of impeded vision. On the Piggott machine the outlook is entirely through windows made of insoluble gelatine, and the passenger and the engine are both situated in front of the pilot. The propeller boss, which is conical, forms a revolving pointed nose on the otherwise hemispherical head of the body.

An almost equally pronounced example of inclosed body-work is given by the Kny aeroplane, constructed by Messrs. Mulliner of London and Northampton, but in this machine the body is boat-like in form, and the pilot and passenger can have, at any rate, nothing but sky above them, if they care to detach the conning tower cover plate. Like the Piggott, the stream-line body of the Kny aeroplane extends to the tail, and the latter part of it is fabric-covered. In front, the outer surfacing material is sheet aluminium. On the Piggott machine, the surfacing material is entirely fabric. Fabric is also used for enclosing the framework of the Nieuport monoplane, for which Maurice Ducrocq has the agency. In this machine, however, the rectangular section of the main frame has not been inclosed by any supplementary casing, as on the Piggott monoplane, and consequently the sides of the body are flat. In appearance, however, the Nieuport monoplane distinctly belongs to the class under consideration, although possibly its right to such classification is based more on appearance than actual design, for there is little doubt that the small size of the horizontal twin-cylinder engine in front considerably enhances the stream-line appearance of the body, which, if fitted with a more conventional motor, might call for less comment, on account of its shape. In the Handley Page monoplane, for example, the engine end of the machine is anything but stream-line like in form, yet there is no better example of stream-line construction at the Show than is provided by the after-part of its body. It has quite a fish-like appearance, and is surfaced throughout in highly-polished three-ply mahogany. As the machine is only designed to carry the pilot, its general lines are characterized by short overall length, and so this particular machine has an uncommonly neat appearance.



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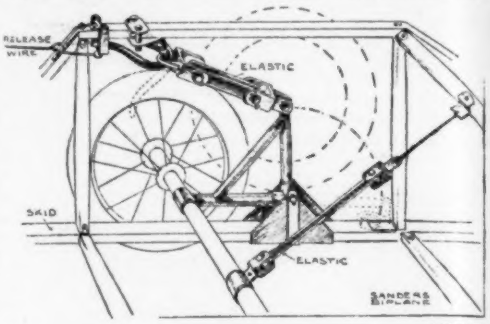
SKETCH SHOWING THE ARRANGEMENT OF THE FRAMEWORK AT THE TAIL OF THE HOWARD WRIGHT MACHINE

More conventional examples of inclosed body-work, in which the surface material is merely laid straight on the frame and forms flat sides, are to be seen in the Blériot, Martin-Handasyde, Bristol and Blackburn monoplanes, and, strictly speaking, it is to this latter category that the Nieuport also belongs.

The most interesting development of inclosed body-work is, however, in connection with some of the modern biplanes which hitherto have always been characterized by the entire exposure of all the principal masses. The most important—as it was also one of the earliest examples of this system of construction—is the Breguet biplane, which may be described as having a monoplane body supporting biplane wings. The body is completely surfaced from head to tail, and is of great length. Unfortunately it has a most ungainly appearance, owing to a peculiar discontinuity in its lines; but this is, perhaps, more pronounced when the pilot is not on board, because the general shape has been based on the aviator's position in the machine and on the amount that his body projects above the level of the frame. A new type of Bristol biplane, which is now being built in addition to the Farman pattern, is designed on Breguet lines, and has the characteristic inclosed body, which, with the single row of struts in the gap and the engine in front, constitute the outstanding features of the Breguet type.

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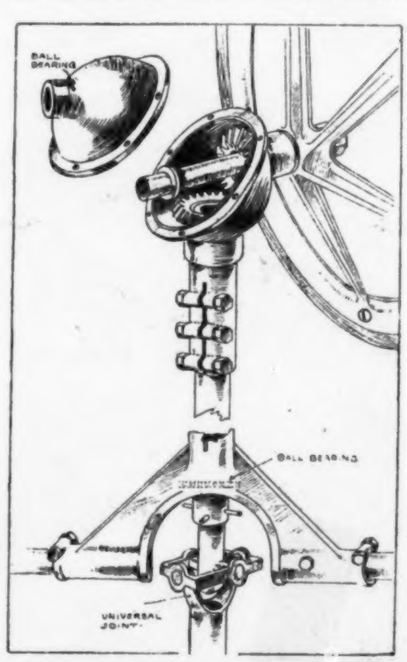
SKETCH ILLUSTRATING THE MECHANISM OF THE DISAPPEARING AXLE ON THE SANDERS BIPLANE

By releasing a catch the axle and wheels are drawn above the level of the skids, on which latter members the machine can therefore land direct.

Various other applications of this principle of inclosed body-work to biplane construction are to be found among the modern examples of the Farman type of aeroplane. The Bristol machine of this pattern, made by the British and Colonial Aeroplane Co., has a kind of car for the pilot and passenger, but the engine, being a rotary Gnome, is exposed. On the genuine Maurice Farman, exhibited by the Aeroplane Supply Company, a similar casing extends around the engine also, which in this case is a stationary Renault, with the propeller mounted on the half-speed cam-shaft. On the Grahame-White biplane the pilot and passenger sit in a dainty little gondola.

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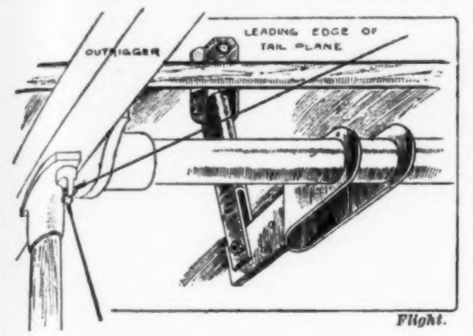
THE MARTIN-HANDASYDE CONTROL GEAR

On the Howard Wright the outrigger carrying the foot-rest is covered in underneath, and forms a kind of tray, but otherwise everything is exposed as in the original design.

Turning to a consideration of the machines at

Olympia from the point of view of their general design, it is interesting to compare them by classification into broader and somewhat more fundamental divisions than results from a mere discussion as to whether they are in the latest mode as regards body construction. There are twenty machines on view, ten of which are biplanes and ten monoplanes. Of the ten biplanes, five may properly be classified as belonging to the Farman type. These include the British-built copies by the British and Colonial Aeroplane Company, Messrs. Howard Wright and Messrs. Grahame-White. Each has minor peculiarities of its




SKETCH ILLUSTRATING HOW THE ATTITUDE OF THE TAIL IS ADJUSTED BY A HAND WHEEL ON THE SOMMER-TYPE HUMBER BIPLANE

own. There is also the Maurice Farman, which differs from the Henry Farman in the flatter appearance of its planes and in the extended skids, which curve up to support the elevator on the Sommer principle. The Sommer type, which may be practically considered as a modification of the Farman design, is represented at Olympia by the Humber biplane. The essential characteristics of the Farman machine, which is unquestionably the most popular aeroplane that has yet been built, are basically that of the original Voisin, from which it was evolved by Henry Farman, who flew the Voisin biplane at a time when he was one of the first men to fly at all. The Farman machine is a biplane with an elevator in front, a tail behind, and the propeller immediately behind the main planes. As the popular type of engine used on this machine is the Gnome rotary, which is always mounted adjacent to the propeller, the principal mass is situated aft of the center of pressure, and consequently the tail is necessarily of the lifting type because the pilot does not, in the accepted position, balance the engine by his own weight.

On the Breguet biplane, where the relative positions of the engine and pilot are reversed, the tail becomes, practically speaking, a non-lifting member, although in actual practice the tail of the Breguet is a slightly cambered plane. Incidentally, of course, the Breguet system facilitates the use of a monoplane type body, because the propeller, being in front, does not interfere with the continuity of the longitudinal spars in the construction of such a member. The inclosing of the body so as to be more or less of stream-like form,

belongs to a separate class. There is the small Wright racer, with which type Mr. Alec Ogilvie competed in the Gordon-Bennett race; the Cody biplane, with which Mr. S. F. Cody won the British Michelin Cup; and the Sanders biplane, which, in some essential features, resembles the biplane originally designed by Messrs. Short Brothers.

The Wright biplane in its present form is characterized by the absence of any front elevator, and by the use of a non-lifting tail. Practically, the machine is in balance about the center of pressure with the pilot on board, and, indeed, the spiral draught from the propellers is enough to upset this balance through its influence on the tail plane.

The Cody biplane is similarly a balanced machine, but it differs from the present Wright type in having an elevator. The elevator on the Cody machine is a cambered plane, and normally carries some of the load for convenience in control, although it is not essential from constructional considerations that it should do so. The engine on the Cody biplane is carried on the lower plane, and, within reason, both it and the pilot can have their positions altered in order to effect any degree of balance that may be required. In practice, as has been mentioned, Mr. Cody prefers that the elevator should be loaded a little, as he considers that it facilitates control.

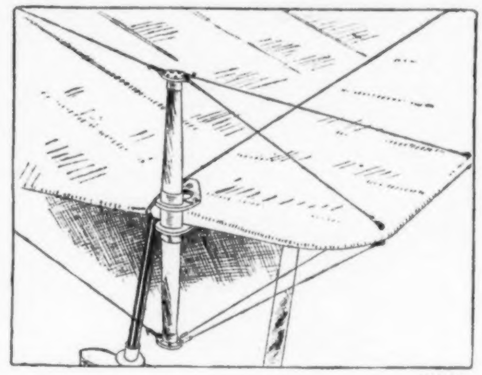
The Sanders aeroplane is fundamentally a modification of the original Wright biplane, as its only tail member is the rudder, and there is an elevator in front. This elevator, however, probably carries proportionately more load than on the original Wright, because the very strong Short type girder undercarriage is probably heavier than the corresponding outrigger on the original Wright machine. These girder skids and the elevator shaft itself are, to all intents and purposes, the same as those on the Short biplane last year. The main planes themselves are characterized by sharply down-turned extremities on the upper plane that act as side curtains to prevent leakage and sideslip. The engine and propeller on the Sanders biplane are arranged more or less on the same lines as the Cody—that is to say, the propeller is mounted midway in the gap and is driven at half engine speed by a single vertical chain. The rudder is a triplane, in which respect it differs from the biplane rudder on the Wright.

If we attempt to compare the monoplanes on a similar basis it is somewhat more difficult to differentiate between types, owing mainly to the gradual merging of the characteristics of the Blériot and Antoinette patterns that have hitherto led the field and been distinct. Thus, for instance, the V-section boatlike Antoinette body may be seen combined with Blériot pattern wings, which are certainly quite distinct from the planes of the true Antoinette, both on account of the fact that they are thinner and also by reason of the absence of individual trussing on the wing spars.

A genuine Blériot, with its characteristic lifting tail, rectangular open girder body and rather low set center of gravity, is exhibited by the London representatives of that firm; while the Martin-Handasyde monoplane may be considered, at any rate as regards its appearance, as characteristic of the real

characteristics, but in the principle of the non-lifting tail they are alike. The Kny has its wing spars individually trussed more or less on the Antoinette principle, but in the other machines mentioned the wing spars are not thus reinforced.

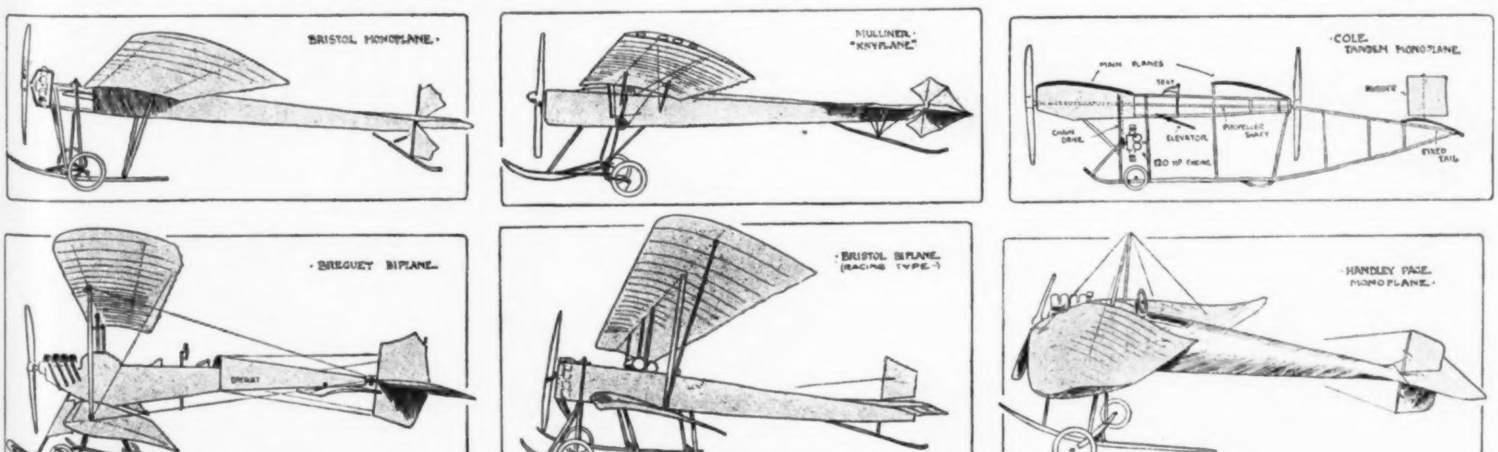
Properly speaking, the real distinction in monoplanes of this classification should be drawn between the tail behind and tail first types, and in the latter category the Valkyrie is at present the only example on view. This machine is of essentially British design and construction. It is characterized by a fixed load-




DETAIL SKETCH ILLUSTRATING THE REAR ELEVATING PLANE ON THE FARMAN BIPLANE.

carrying leading plane in front of the main plane, which leading plane must not be confused with the movable elevator that is also provided. In the Valkyrie machines the propeller, engine and pilot are likewise all in front of the main plane. In the Antoinette monoplane the engine and propeller are both appreciably in front of the main plane, and on the Blériot monoplane the engine and propeller are still in front, but distinctly closer to the leading edge. Inasmuch as the central portion of the Valkyrie main plane is recessed to take the propeller, the engine—supposing it to be a Gnome rotary—is not really so much further forward of the leading edge proper than it is on the Antoinette, and thus the essential distinction is more or less confined to the change in the position of the pilot. Appearances are therefore apt to be a little deceptive in respect to the relative distribution of weight with this particular design.

A monoplane that is altogether in a class by itself is the Dunne, which is, so far as practical flying machines are concerned, an evolution of the Dunne biplane. The biplane was in itself, however, originally evolved from still earlier monoplane models. A characteristic feature of this machine is the absence of a tail and the V-plan form of the wings, which also have a varying angle of incidence from root to tip. The object of the design is the acquisition of natural stability, and the purpose of sloping back the wings is to acquire an overall length for the machine as distinct from the chord dimension. This increment in length virtually introduces the principle of a tail, and the change in the angle of incidence through-




VARIOUS TYPES EXHIBITED AT OLYMPIA

Drawings reproduced from *Flight*.

which feature has already been discussed, is, of course, only a natural evolution as the outcome of taking a further step in detail design. While on the subject of the Breguet machine it should also be mentioned that quite apart from the question of type this model belongs to a class apart in any case, because it is constructed entirely of steel—timber being now, as formerly, the standard material for aeroplane framework. The Breguet-type aeroplane made by the British and Colonial Aeroplane Company is constructed of wood.

Of the three remaining biplanes at Olympia, each

Antoinette. It has the triangular section covered frame, non-lifting tail and individually trussed wing spars. As a design, however, the Martin-Handasyde monoplane is full of original detail.

Machines like the Blackburn and Bristol monoplanes may be classified as lying between these two distinct types, inasmuch as they have Antoinette bodies with wings that certainly bear more resemblance to the Blériot pattern than the Antoinette, and are, at any rate, trussed only to one central mast.

In the Kny, Piggott, Handley Page and Nieuport monoplanes the body form predominates over all other

out the succeeding sections of the wings confers the principle of the dihedral angle on the relative attitude of the virtual tail portion in respect to the central leading portion of the machine.

In fundamental principle the Valkyrie appears to be not dissimilar to the Dunne, although there is no structural likeness whatever. The leading plane in the Valkyrie, however, may be likened to the central portion of the Dunne machine, and it makes a dihedral angle in respect to the main plane, the extremities of which correspond to the rearward tips of the Dunne wings. This comparison is, perhaps, not altogether

conclusive as thus briefly drawn, but it has been made with the object of emphasizing that it is in the underlying principle rather than in the form of the machine that types should be compared on a common scientific basis. The Handley Page monoplane, for example has the sloped back wings arranged with a crescent plan form of leading edge, and the dihedral angle is present in a minor degree by the use of upturned flexible wing tips. Apart from the shape of its wings, however, the Dunne monoplane is characterized by its underhung load, the engine and pilot being situated beneath the wings. In the Sanders biplane, which in this respect represents the principle of the early Wright flyer, the elevator may be regarded as a forward tail; but as its attitude can be varied at will, stability is dependent on the action of the pilot.

Thus far we have discussed the machines that are already familiar to readers of *Flight*, and indeed it is one of the most satisfactory features of the present exhibition that so much of the display is admittedly within the realm of successful practice. No one can possibly say that the present exhibition lacks originality in aeroplane design, and yet it is singularly free from freaks. Practically the only purely speculative designs are the tandem monoplane exhibited by Messrs. William Cole, and the machine exhibited by Mr. F. L. Bartelt. Of these the former is unfinished, and is thus possibly in some degree exempt from criticism, so we would therefore confine ourselves to saying that it labors under the disadvantage of having an unprepossessing appearance. The design is due to a Frenchman, M. Magnodex, and attacks a particularly interesting problem in aeroplane construction. The tandem monoplane was on the point of being the first machine to fly in America when Langley was tripped up by ill-fortune in his endeavor to demonstrate a full-sized machine of this type before representatives of the American Government. Langley had succeeded in obtaining very successful flights with large power-driven models, and his construction of a man-carrying aeroplane was undertaken at the instigation of the American Government, as a direct outcome of his previous work. Faulty launching ways twice brought about temporary disaster to the machine, and the authorities, having little faith in those days, withdrew their support. Within a few weeks the Wright Brothers had secretly succeeded where Langley failed, and in the evolution of their machine the tandem monoplane has been forgotten.

The necessity for overall length on a machine as a factor in its stability, and the necessity for providing an adequate body in order to carry the tail, certainly suggest the possibility of developing a useful type in the tandem monoplane, since it plausibly offers an opportunity to provide twice the lifting surface for the extra weight of a pair of wings. Whether or no the Cole machine will succeed as the modern prototype of this class we should not like to say. In its present form it certainly seems to us to be following an undesirable principle in attempting to combine such unknown quantities as a tandem monoplane, wooden folding wings, twin propellers, and a new type of rotary engine on the same machine.

The Bartelt machine is something apart from all accepted types. It consists of a steel structure of biplane appearance with loose, saggy wing surfaces. The wings are mounted at their shoulders on cranks, whereby they rise and fall, while always remaining parallel to the ground. The motion of the cranks being circular, the wings, simultaneously with their rise and fall, move forwards and backwards—in other words, they perform a modified form of paddle action, the object being to derive support by beating the air. The wing motion is obtained from chain transmission, and in addition to the supporting reaction, there is said to be a propelling force sufficient to keep the machine going without the small propeller that is such a comparatively insignificant constructional feature of the machine as a whole. We are informed that the small scale prototype of the machine exhibited actually flew with a pilot weighing 8 stone 4 lbs.

# The Air-brake as Related to Progress in Locomotion—III*

## The History of a Great Invention

By Walter V. Turner, Chief Engineer, Westinghouse Air Brake Co., Pittsburg, Pa.

Continued from Supplement No. 1841, page 230

To consider for a moment the quantitative results of the improvements which have been mentioned as evidenced by the comparative stopping distances of trains equipped with the types of brakes referred to. The diagram (Fig. 18) shows concretely the relative efficiency of the various forms of brakes for passenger trains, the difference in the length of the lines corresponding approximately to the reduction of distance required in which to stop a given train of one locomotive and six cars from a speed of 60 miles per hour since the introduction of the air-brake. If the diagram were inverted so that it is viewed upside down, a fair idea will be obtained of what the relation between the stops would have been through the respective periods of train development had there been no change in the air-brake since first applied.

The tendency of modern rolling stock to lower brake efficiency is further illustrated in Fig. 19. The

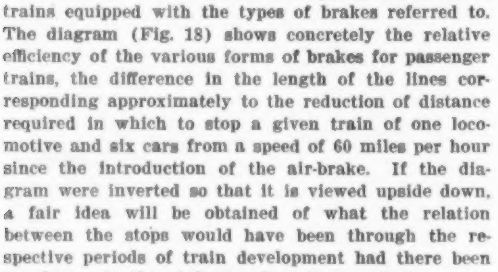



Fig. 18.—DIAGRAM OF DEVELOPMENT OF AIR-BRAKE EFFICIENCY SINCE 1869

retardation curves show the stopping distance from about the same initial speed of a train composed of cars weighing 30,000 pounds and braking at 83 per cent, and a train of 84,000 pound cars braking at 150 per cent. It will be seen that notwithstanding the 60 per cent greater braking power of the heavier train, the difference in stop is not greatly in its favor. The reason for this is clear when it is considered that the work done during the stop for the light train was 14.5 foot-tons per brake-shoe per second while with the heavy train it was 29 foot-tons per brake-shoe per second, which shows that under modern conditions each brake-shoe is doing about twice the amount of work required formerly in order to make approximately the same stop, which consequently lowered the coefficient of friction and thus tended to equalize the actual retarding forces developed in the two cases.

The diagram below the comparative curves shows, first, the length of stop for light train with the equipment of its day; second, what the stop would have been with the heavier train had there been no change in brake equipment to correspond to the increased weight of train; third, what braking power was actually required to stop the heavy train in the distance the light train was stopped with its brake equipment; and fourth, what the stop of the light train would be if it were possible to apply to it the brake equipment required for the heavy train. This is a significant and all-sufficient example of what is required to meet modern conditions as effectively as they were provided for in the past.

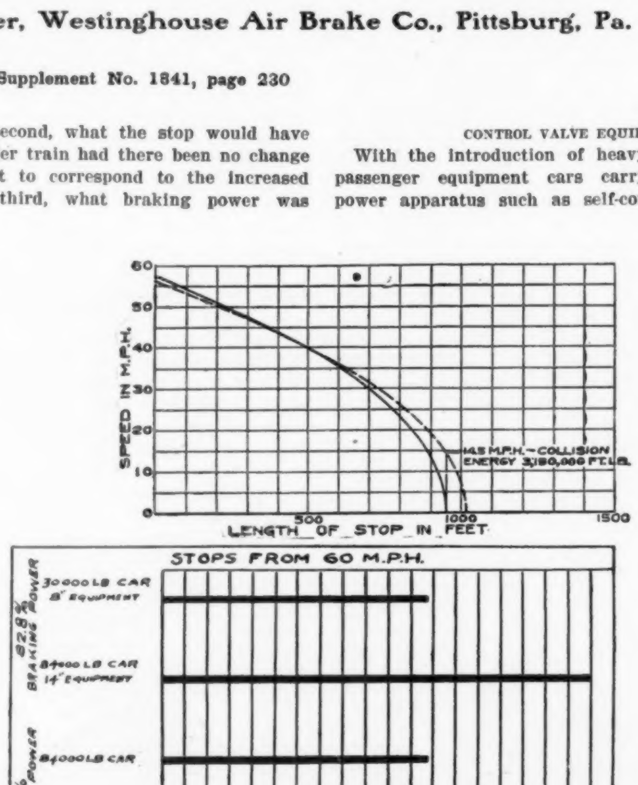



Fig 19.—COMPARATIVE RETARDATION CURVES AND BRAKING POWER CHART FOR TRAINS OF 1875 AND 1907

| Date | Speed in M.P.H. | Lgth. of stop in feet | Time of stop in sec. | Wght. of trains, tons | Work in ft.-tons performed by brakes | | | B. P. p. c. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Total | Per sec. | Per brake-shoe per sec. | |
| 1875 | 56.0 | [illegible] | 22.0 | 227 | [illegible] | 1086.4 | 14.70 | 82.8 |
| 1907 | 57.5 | 954 | 18 | [illegible] | [illegible] | 3278.0 | 28.75 | 150.0 |

Dotted curve shows stop on Midland Railway, 1875, with the Westinghouse Automatic-Brake.

Full-line curve shows stop made on W. J. and S. R. R., 1907, with the Westinghouse "LN" Brake.

Had the braking power as shown in the last column of the table and represented by the full-line curve, been 134 per cent instead of 150 per cent, the two stops would have been the same.

CONTROL VALVE EQUIPMENT.

With the introduction of heavy sleeping cars and passenger equipment cars carrying heavy motive power apparatus such as self-contained motor cars, not only were the factors above mentioned, which tend to lower brake efficiency, aggravated to a marked degree, but limiting conditions were encountered in other directions. The brake force required to control such heavy (135,000 to 170,000 pound) cars with approximately the same effectiveness obtainable with the apparatus used on lighter cars became so great as to exceed the capacity of a single brake-cylinder

* Presented at the meeting of the Mechanical and Engraving Section of the Franklin Institute.

even with the highest brake-cylinder pressure and greatest multiplication of its power by leverage that could be permitted.

The single brake-cylinder had already reached a maximum of 18 inches in diameter, and it was generally agreed that a larger size brake-cylinder would be impracticable from a manufacturing, operative and maintenance standpoint.

With 100 to 105 pounds brake-cylinder pressure being obtained from 110 pounds brake-pipe pressure carried there was little hope of raising the cylinder pressure higher, and no materal or permanent improvement in the general condition would result even if the full 110 pounds could be realized in the brake-cylinders.

There was no suggestion of an increase in brake-pipe pressure above the present standard, it being universally recognized that 110 pounds was about as high as could safely and economically be used with the type of apparatus and fixtures in general service.

The multiplication of the brake-cylinder pressure through the leverage of the foundation brake rigging had been carried, in many cases, beyond the recommended 9 to 1 maximum simply because it was the most obvious, simplest, and most convenient means of providing the heaviest cars with a proportionate braking power approaching that used on lighter cars. The evils of this expedient soon became manifest in dragging brake-shoes, "slow release" and trouble in keeping the brake rigging properly adjusted. Most important of all, from a safety standpoint, was the effect of this high leverage ratio in multiplying the losses due to lost motion in the rigging or truck members, brake-shoe movement and so on, the result of which was evidenced in excessive false piston travel and consequent failure to obtain the maximum brake-cylinder pressure contemplated in the design, or still more serious loss in braking power due to the piston traveling so far as to bottom on the cylinder head.

These and other mechanical limitations therefore barred further progress in this direction, and two alternatives remained, viz.:

1. To increase the effectiveness of the single brake-cylinder as far as possible by using two brake-shoes per wheel (clasp brake).

2. To use two brake-cylinders per car.

While the first of these alternatives would undoubtedly be of some assistance, there are objections to this design, not the least of which is a reasonable doubt whether the acknowledged theoretical advantages of the clasp brake would prove to be practicable; and a reasonable certainty that no matter to what extent its theoretical advantages might be realized in practice, the maximum increase in efficiency thus afforded could not be sufficient to meet the demands of conditions already existing, to say nothing of the possibilities of the future.

On the other hand, the two-brake-cylinder proposition did not necessarily involve any new or untried principles, since two complete equipments of the type already in service might be used, one for each end of the car. This would provide ample stopping power for existing conditions, and lend itself readily to extension, as still more severe demands might arise. It was therefore recognized that such an arrangement offered the best solution of the problem of the proper air-brake equipment for passenger cars weighing 130,000 pounds or over. Furthermore, it was seen that a single valve mechanism to control the admission of air to and release of air from the two-brake-cylinders would possess such marked advantages over a complete double equipment for each car as to make a satisfactory and practicable design of such a valve greatly to be desired. In reality, the success and scope of the two-cylinder arrangement depended wholly on the characteristics of the valve device adopted for this purpose.

It was but logical that, in the first practical solution of this problem, use was made of the same principles, both of construction and operation, as had been embodied in a valve device already in use for some years, and giving the best of satisfaction under conditions quite similar to those of the two-cylinder passenger-car equipment. While this valve (the distributing valve of the "ET" locomotive brake equipment) was particularly designed to operate in connection with two or more brake-cylinders on locomotives, its distinctive operative features were equally advantageous for passenger car service. Consequently, when the introduction of 85-ton multiple unit electric motor cars on the N. Y., N. H. & H. R. R. electric zone called for a correspondingly effective form of brake apparatus, of necessity using two-brake-cylinders, the valve mechanism adopted was a modification of the distributing valve type, the changes being only such as were required to adapt this device to passenger train service. From the start, its performance under the severe demands of suburban electric service was so satisfactory as to thoroughly establish the advantages of this type of equipment for the high braking efforts and large brake-cylinders required by the heavier classes of cars. It is hardly necessary, however, to go further into detail regarding its construction or operation, first, because the design of its operating mechanism resembles so closely that of the distributing valve, and, second, since it served to mark one stage only in the development of a distinct type of brake apparatus for such service.

As already stated, with the advent of passenger-carrying cars weighing from 135,000 to 150,000 pounds in steam road service and still heavier motor cars, carrying extraordinary dead weight loads, the limit of an efficient single-cylinder equipment was approached and in some cases exceeded. But this was only one phase of the situation. The demand of high speed heavy train service had steadily advanced to a point where, for adequate control, something more was required of a brake than merely maximum retarding power in emergency. The ordinary service functions and automatic safety and protective features became hardly secondary in importance. Briefly stated, the requirements recognized as essential in a satisfactory brake for this modern service are as follows:

1. Automatic in action.
2. Efficiency not materially affected by unequal piston travel or brake-cylinder leakage.
3. Prompt serial service action.
4. Graduated release.
5. Quick recharge and consequent ready response of brakes to any brake-pipe reduction made at any time.
6. Predetermined and fixed flexibility for service operation.
7. Full emergency pressure obtainable at any time after a service application.
8. Full emergency pressure applied automatically after any predetermined brake-pipe reduction has been made after equalization.
9. Emergency braking power approximately 100 per cent greater than the maximum obtainable in service applications.
10. Maximum brake-cylinder pressure obtained in the least possible time.

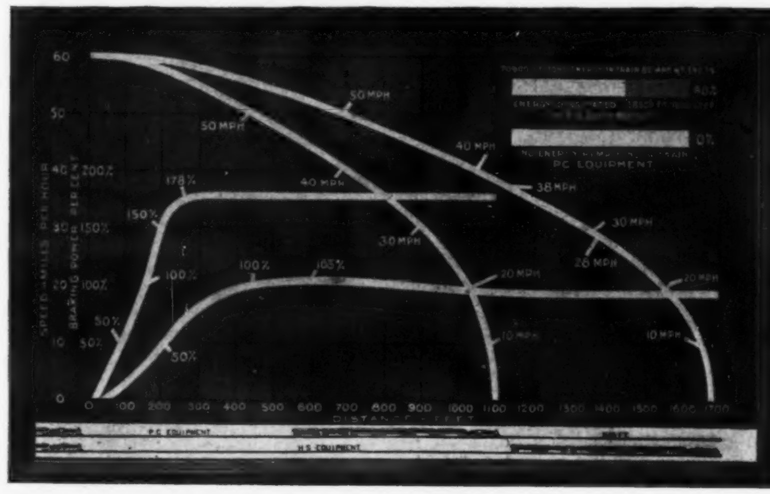



FIG. 21.—COMPARATIVE TRAIN STOPS, CONTROL VALVE AND HIGH-SPEED BRAKE EQUIPMENT

11. Maximum brake-cylinder pressure maintained throughout the stop.
12. Brake rigging designed for maximum efficiency.
13. Adaptability to all classes and conditions of service.

That certain of these requirements demanded radical changes in the valve device used on the car is evident from a comparison with the functions of the previous types already referred to, since but one of these required functions was contained in the older equipment. These considerations led to the latest development in the art of controlling heavy, high-speed passenger trains, employing what is known as a control valve in the place of a triple valve, the functions of which have already been mentioned in brief. The complete equipment is known as the schedule "PC," and is illustrated in Fig. 20.

The relative stopping power of the most efficient of the old order of brake apparatus—the high-speed brake—and of the control valve apparatus, is contrasted in the curves of Fig. 21. Both the comparative lengths of stop and the relative rates of rise and amount of maximum braking power are shown by the curves. It will be noted that the 575 foot shorter stop made with the "PC" equipment resulted not only from the higher braking power utilized, but also from the quicker rate at which this braking power was built up to its maximum value. As a result you will note that the speed of the high-speed equipment train when passing the point (1,100-foot stake) at which the "PC" equipment train stopped, was still as high as 38 miles per hour, which means that 40 per cent of its initial kinetic energy (at 60 miles per hour) still remained to be dissipated (harmlessly in this case, fortunately) before the train could be stopped.

Moreover, not only was this speed 38 miles per hour in the case of the high-speed equipment train, but it passed the 1,100-foot stake six seconds before the "PC" equipment train reached that point. That is to say, the train with the "PC" equipment came to a stop at the 1,100-foot stake six seconds after the train equipped with the high-speed equipment passed this

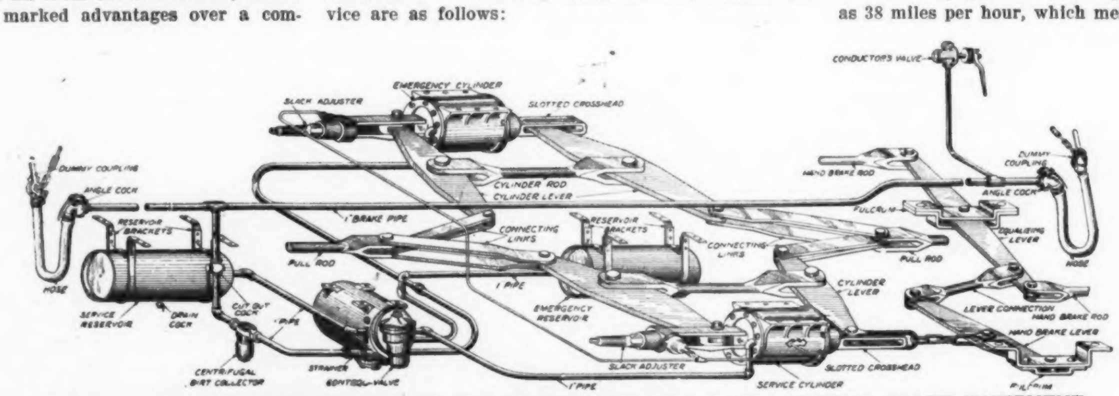



FIG. 20.—IMPROVED BRAKE EQUIPMENT FOR HEAVY PASSENGER CARS; CONTROL VALVE EQUIPMENT; SCHEDULE "PC"

point at a speed of 38 miles per hour. At the time when the "PC" equipment train stopped at the 1,100-foot stake, the train equipped with the high-speed brake equipment was 275 feet farther on, and still running at a speed of 28 miles per hour, which corresponds to a kinetic energy 22 per cent of the original amount when train was running at 60 miles per hour.

SUMMARY OF DEVELOPMENT IN PASSENGER BRAKES.

From what has gone before, it will be seen that the existence and development of the passenger brake devices which have been described have come about, not spontaneously, of themselves, or solely for themselves, but in response to a definite need or for the purpose of accomplishing certain necessary and desired results, the end in view always being the safeguarding of life and property and increasing the facility, economy, and dispatch with which larger volumes of traffic can be handled.

Briefly, the conditions to be overcome and the objects to be attained may be summarized as follows:

Conditions.—Increased weights of trains, greatly decreasing the relative efficiency of the brake and increasing the energy to be overcome in bringing the train to a standstill. Of two trains on the same number of wheels having the same nominal percentage of braking power, one being twice the weight of the other, the heavier train will run at least one-third further than the other.

Higher running speeds, increasing the energy to be overcome in making the stop in proportion to the square of the speed and adding directly to the length of stop according to the time required to obtain effective braking power on the train as a whole.

Greater frequency of trains, which increases the necessity for stopping quickly in a rapidly increasing ratio. Not only is it of more importance than ever that the trains be readily controlled within the distances between signals, but, with double or four-track roads, there is the added greater possibility of the track on which the train is running being blocked by a break-in-two or other accident on the opposite track.

Increasing insistence upon the comfort and convenience of passengers and at the same time for greater economy in the handling of traffic, the latter being, in the nature of things, antagonistic to the former, without some special provision is made, looking to ultimate rather than circumstantial economy.

Object of Improvements.—*In Service Applications.*—(1) Much more flexible control of the train, greatly reducing possibility for shocks. (2) More uniform braking power, reducing surging in trains and flat wheels. (3) Uniform and maintained cylinder pressure notwithstanding variations in piston travel or leaky brake cylinders. (4) Constantly recharged auxiliary reservoirs, which increase the safety to the highest degree. (5) Better protection against excessive braking power in service applications. (6) Shorter, smoother and more accurate stops.

*In Emergency Applications.*—(1) The human factor in the equation is reduced to a low point. (2) The increased percentage of braking power and prompt rise of brake-cylinder pressure compensates in a large degree for the decrease of the retarding force due to the increased work the brake shoe now has to perform as compared with the old style brake. (3) Trains can be stopped in somewhere near the same distance as when the cars were lighter. (4) *Emergency pressure is available even after a service application has been made to an extent never before attained.*

EMPTY AND LOAD BRAKES.

Under modern freight-traffic conditions, as already stated, uniformity of retardation on all cars in a train is second in importance only to safety. This, with mixed loads and empties hauled in the same train, is inherently unobtainable with the type of brake considered thus far. It can only be accomplished by providing means whereby a relative braking force more nearly comparable to that of the empty car can be utilized on the partially or fully loaded car.

The difference in braking power with the standard brake on loaded and empty cars would no doubt astonish anyone unfamiliar with the facts, but can be appreciated from the statement that the same brake-cylinder pressure which gives 60 per cent braking power on an empty car will give only from 17 per cent to 20 per cent when this car is fully loaded.

Four possible solutions are evident:

1. *Increased Brake-cylinder Pressure for a Given Reduction and on Equalization.*—In order to leave the braking power on the empties the same as at present but increase that on the loaded car to the desired amount, it would not be permissible to increase the brake-pipe pressure above the 70 pounds at present generally used. Even if an increase above 70 pounds *for this purpose* were permissible, it would not give any higher braking power for ordinary service reductions, but only afford a higher equalization pressure. An increase of reservoir volume, on the loaded car is therefore another alternative. The maximum increase in pressure then available could not be greater than 70 pounds which, while only increasing the braking power on the loaded car by 40 per cent (that is, from, say, 20 per cent to 28 per cent braking power) at the most, would destroy many fundamental and necessary features of the brake. This is only about one-fifth or one-sixth of the increase required for a proper control of a car loaded to from two to four times its light weight. This method is therefore impracticable.

2. *Increase the Total Leverage Ratio Temporarily on the Loaded Car.*—In the first place, the total leverage ratio for the heavier modern freight cars and standard equipment is already so high that any such increase as required by the loaded car would be prohibitive. Aside from this, however, it has been demonstrated by many repeated but futile attempts that none of the various schemes thus far proposed for mechanically changing the leverage to correspond with the increase in car lading (whether automatically with an increase of car weight or manually) can be made practicable for actual road service. Once established for the light car, the same leverage ratio must be utilized for the loaded car.

3. *A combination of increased leverage ratio and auxiliary reservoir volume* might be suggested as a possibility, but it would evidently combine the objectionable features of the first and second alternatives just mentioned in such a manner as to aggravate the undesirable effects of each. This method, therefore, fails to afford the relief sought.

A fourth possibility remains, viz.:

4. *A Second Brake-cylinder to be Added to the Ordinary Brake Cylinder to Control the Load.*—A number of equipments of this type, of varying form, are being successfully operated on a number of railroads, particularly in mountain grade service, where the additional braking power thus provided is of advantage in increasing the amount of tonnage handled in a given time down the grade. It will be of interest to state, in outline only, the characteristic features of forms which have proven successful.

1. Two brake cylinders per car are used, one for the empty car and both used together when the car is loaded to say two-thirds or more of its rated capacity.

2. Standard leverage arrangement for the "empty" brake cylinder.

3. Suitable connections, take-up mechanism, levers, etc., to form the connection and required multiplication of power from the additional "load" cylinder to the "empty" cylinder lever system.

4. Valve mechanism, in addition to that required by the "empty" brake, for controlling the supply of air to and from the added or "load" brake cylinder.

5. Semi-automatic change-over valve mechanism for cutting the "load" brake in or out either manually or under certain circumstances, automatically.

6. Additional reservoir capacity to furnish the air supply for the "load" brake.

The important problems entering into the operation of brakes on freight trains under present-day intensive traffic duty, for which the "empty and load" type of apparatus offers an ideal solution may be briefly as follows:

1. The necessity for more braking power on loaded cars than afforded by the ordinary form of brake, in order to increase the tonnage which can be handled down long or heavy grades with safety. Locomotives of such power are now built, that it is possible, in some localities, to haul heavier trains to the top of a grade than can be safely controlled down the other side with the standard brake.

2. Trains of mixed loads and empties, especially long (50 to 100 cars) trains, where it is physically impossible or economically impracticable to arrange the empty and loaded cars in the train to the best advantage, thus adding greately to the danger of the train parting or damage to the lading and equipment due to inequality of braking power in different parts of the train, when the brake is applied at some critical speed or locality.

3. Locomotives of great weight, but relatively low braking power, tending to increase the internal stresses in the train due to unequal retardation on different cars in the train.

4. The advent of large capacity cars, aggravating the differences in retardation due to lading, so that the percentage of braking power on such cars, when loaded, is reduced to a greater extent than on cars of lower capacity, for which the proportion of loaded to light weight is less.

5. The requirement of operating both short and long freight trains with practically all air brakes cut in. This, on a long train, with loads ahead and empties on the rear end, presents an operating problem difficult of solution with the old standard brake.

PRINCIPLES OF TRAIN BRAKING AND BRAKE DESIGN.

Throughout the foregoing description of the development of the various types of brake apparatus, occasion has been taken to explain at the same time the operating conditions and service requirements responsible for their being. While this has necessarily involved some reference to some of the fundamental principles underlying the proper application and operation of brakes as related to convenience, economy and safety in train control, there are certain limiting conditions and fixed laws which should be treated more specifically and in detail. This is not so much because the present state of the air-brake art exemplifies the application of these laws and principles to the complex demands of modern freight and passenger service, but rather because it is only by a careful study and sound working knowledge and appreciation of the significance of these laws that anyone is able to judge positively and accurately, on the one hand, the adaptability of, or necessity for, any new air-brake device, and on the other, what are the requirements to which any new device or method must conform in order to adequately and efficiently satisfy the requirements of new service conditions.

(To be continued.)

## RULES GOVERNING THE COMPETITION FOR THE $15,000 FLYING MACHINE PRIZE OFFERED BY MR. EDWIN GOULD.

1. A prize of $15,000 has been offered by Mr. Edwin Gould for the most perfect and practicable heavier-than-air flying machine, designed and demonstrated in this country, and equipped with two or more complete power plants (separate motors and propellers), so connected that any power plant may be operated independently, or that they may be used together.

CONDITIONS OF ENTRY.

2. Competitors for the prize must file with the Contest Committee complete drawings and specifications of their machines, in which the arrangement of the engines and propellers is clearly shown, with the mechanism for throwing into or out of gear one or all of the engines and propellers. Such entry should be addressed to the Contest Committee of the Gould-Scientific American Prize, 361 Broadway, New York city. Each contestant, in formally entering his machine, must specify its type (monoplane, biplane, helicopter, etc.), give its principal dimensions, the number and sizes of its motors and propellers, its horse-power, fuel-carrying capacity, and the nature of its steering and controlling devices.

3. Entries must be received at the office of the Scientific American on or before June 1st, 1911. Contests will take place July 4th, 1911, and following days. At least two machines must be entered in the contest or the prize will not be awarded.

CONTEST COMMITTEE.

4. The committee will consist of a representative of the Scientific American, a representative of the Aero Club of America, and the representative of some technical institute. This committee shall pass upon the practicability and efficiency of all the machines entered in competition, and they shall also act as judges in determining which machine has made the best flights and complied with the tests upon which the winning of the prize is conditional. The decision of this committee shall be final.

CONDITIONS OF THE TEST.

5. Before making a flight each contestant or his agent must prove to the satisfaction of the Contest Committee that he is able to drive each engine and propeller independently of the other or others, and that he is able to couple up all engines and propellers and drive them in unison. No machine will be allowed to compete unless it can fulfill these requirements to the satisfaction of the Contest Committee. The prize shall not be awarded unless the competitor can demonstrate that he is able to drive his machine in a continuous flight, over a designated course; and for a period of at least one hour he must run with one of his power plants disconnected; also he must drive his engines during said flight alternately and together. Recording tachometers attached to the motors can probably be used to prove such performance.

In the judging of the performances of the various machines, the questions of stability, ease of control, and safety will also be taken into consideration by the judges. The machine best fulfilling these conditions shall be awarded the prize.

6. All heavier-than-air machines of any type whatever—aeroplanes, helicopters, ornithopters, etc.—shall be entitled to compete for the prize, but all machines carrying a balloon or gas-containing envelope for purposes of support are excluded from the competition.

7. The flights will be made under reasonable conditions of weather. The judges will, at their discretion, order the flights to begin at any time they may see fit, provided they consider the weather conditions sufficiently favorable.

8. No entry fee will be charged, but the contestant must pay for the transportation of his machine to and from the field of trial.

9. The place of holding the trial shall be determined by the Contest Committee, and the location of such place of trial shall be announced on or about June 1st, 1911.

# Wireless Telegraphy and Airships

## A Review of Recent Experiments

### By the Paris Correspondent of the Scientific American

Capt. Ferrié, who is at the head of the Eiffel Tower wireless station, and chief of the government wireless department, has been making experiments for some time upon the question of wireless telegraphy as applied to airships. We give the leading results of this work, which are contained in a paper presented to the Telegraphers' Institution of Paris.

For wireless work in connection with airships, we require upon the airship both an antenna or aerial wire, and also a ground connection or its equivalent. We will first refer to the question of the ground wire, as this is important. In Fig. 1 we have the usual connections for a wireless plant as are used in various stations, and here $A$ is the aerial wire and $T$ the ground. At $E$ is the sending apparatus, and $R$ the receiving apparatus, either of which can be connected in.

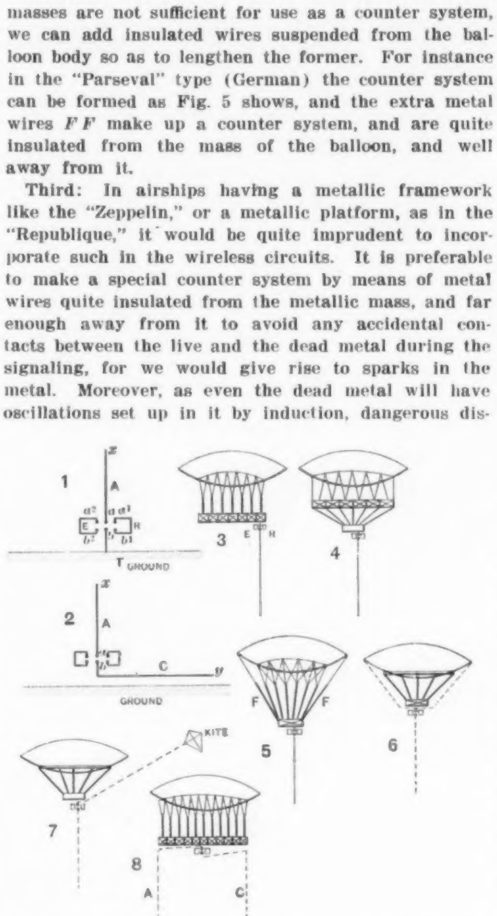
In certain cases we may obtain reasonably good results by replacing the ground wire of the aerial system by a connection with one or more insulated wires stretched above ground and equivalent to the aerial from an electrical standpoint. Such a system is known as a "false ground," or counter-wire. It can be used when a good ground connection cannot be made, for instance in rocky soil. In Fig. 2, the ground is replaced by the "false ground" $C$. To transmit, we connect the points $a$ and $b$ respectively with $a_2$ and $b_2$; and for receiving, with $a_1$ and $b_1$. It is demonstrated both by theory and by practice that while signals are being sent, the tension due to the waves is not constant over the length of the aerial or the combination of this with the false ground or counter-wire. This tension is greatest at the ends $x$ (Fig. 1) or $x$ and $y$ (Fig. 2). At these points occur brush discharges which are stronger as the power used in the waves is greater. Seeing that greater power is needed when making long distance transmission, it follows that such discharges are greater in long-distance work. However, the brush discharges depend not only upon the energy used in the aerial, but also upon the method used in producing the sparks. Taking the three cases, occasional sparks, musical sparks, and continuous wave-trains, in the first two cases we store up electrical energy in condensers from which we produce a periodic spark discharge. When the number of discharges is small, the energy spent in each spark is evidently greater than where we have a considerable number of sparks. The consequence is that the electric tension in the aerial and especially at the ends $x$, or $x$ and $y$ (Figs. 1 and 2) is weaker as the number of sparks is greater, and the brush discharges follow the same law. The use of musical sparks, whose number is such that the noise produced becomes a musical sound, allows of greatly reducing the brush discharge. With a continuous wave train we have a still greater diminution, but we will not dwell upon this method, as it is not yet found to give really practical uses. The factor of the brush discharge is an important one in order to prevent explosion of the hydrogen of the balloon, as we will further see.

To install a wireless plant upon an airship, we must evidently use a mounting with "counter-wire," analogous to Fig. 2. On the other hand, as it is shown that the brush discharges produced at the ends of the antenna and the counter-wire will ignite the hydrogen, we must reduce this discharge to a minimum, and to do this we use musical sparks. Besides, it is required to suppress or mask, all sparks which may be formed in the air, especially in the wave-generating apparatus which may cause an explosion in the hydrogen escaping from the balloon. It is also prudent in all cases to quite avoid making a transmission when the balloon valves are opened, or when there is an accidental rent in the envelop. Various dispositions for the aerial and the counter-wire are used according to the different types of balloons. In all cases we generally form the aerial by a single wire from 100 to 200 meters (328.1 to 656.2 feet) in length, which is hung down from the nacelle after having somewhat loaded it so as to avoid difficulty when the airship is moving. As to the counter wire system, it can be planned in several different ways.

First: By using the metallic mass of the nacelle and suspension wires. However, the balloon proper must be sufficiently distant from the metallic extremities of the steel suspension wires, etc., so that the electric discharges produced at these points have no risk of igniting the hydrogen which may come from the balloon. A distance of 2 meters (6.56 feet) is sufficient here. Besides it is a good plan to provide any metallic points which exist, with metal balls so as to diminish the discharges which take place from such metal points. We show several methods. In the "Col. Renard" type of airship, for instance, we may use the mounting shown in Fig. 3. The metal parts are shown in heavy lines, and the transmitting and receiving apparatus $E$ $R$ are here shown outside of the nacelle for clearness. In the "Gross" type (German) we can proceed in an analogous manner (Fig. 4), and the counter-wire system is formed by the steel-work from which the nacelle is suspended, together with the nacelle itself.

Second: If the linear dimensions of the metallic masses are not sufficient for use as a counter system, we can add insulated wires suspended from the balloon body so as to lengthen the former. For instance in the "Parseval" type (German) the counter system can be formed as Fig. 5 shows, and the extra metal wires $F$ $F$ make up a counter system, and are quite insulated from the mass of the balloon, and well away from it.

Third: In airships having a metallic framework like the "Zeppelin," or a metallic platform, as in the "Republique," it would be quite imprudent to incorporate such in the wireless circuits. It is preferable to make a special counter system by means of metal wires quite insulated from the metallic mass, and far enough away from it to avoid any accidental contacts between the live and the dead metal during the signaling, for we would give rise to sparks in the metal. Moreover, as even the dead metal will have oscillations set up in it by induction, dangerous discharges might be produced at the pointed parts of the metal. It is a good plan to section the metallic cables as much as possible by insulating pieces, for the electric discharges will be weaker as the dimensions of the metal parts are less. In Fig. 6 we observe such a method which could be used on the "Republique" type. It is also proposed to form the counter system by a metal wire which is held by a kite, and this could be applied to any type of airship, but the kite might hinder the proper movement of the airship. In cases where we have a very long nacelle, the aerial and counter system could be placed in symmetrical positions (Fig. 8) at $A$ and $C$, both of them being insulated from the metallic mass of the nacelle. Such a method has the drawback of not giving the same working range in all directions, as the waves radiated from $A$ will interfere with those from $C$. There will be thus a maximum range in one of the planes and a minimum in the other.




DIAGRAMS OF WIRELESS WORK IN CONNECTION WITH AIRSHIPS

As regards the sparks produced by the apparatus itself, at the brushes of the dynamos, etc., it is easy to take the needed precautions by using wire gauze protectors as we find in miners' safety lamps. For producing the current there is generally used an alternating current dynamo having a musical frequency, which can be connected to one of the shafts by a friction clutch. A 2 to 4 horse-power size is sufficient in general. As to the receiving apparatus, there is nothing special to note. However, the noise of the motor hinders the reception by means of telephones, and we sometimes need to use a coherer and a register, so that the apparatus becomes more complicated. It is best to keep the telephone method and use a land station which has enough power to give a loud sound in the telephones. Reception of messages by the airship is besides a secondary matter, as the crew has all the needed instructions before the start, and it is not likely that any others would need to be sent while *en route*. The reception on board is generally confined to some conventional signals to show when messages are received, demands for repeating messages, etc.

In closing, we will mention a few points as to the range which airship plants can reach. We must distinguish two classes of range, first, the range at which the airship messages can be received on the ground, and second, the range from ground to airship. The first of these is the most important. It depends upon the energy of the waves and the dimensions of the aerial and counter system. It thus depends on the plant which can be realized on the airship, but it also varies with the lay-out of the ground plant. When this latter has a large aerial, the range is evidently larger than what we have with a small antenna such as the military field posts possess. The range of receiving may be very long and reach some hundred miles when we use a powerful land station. The total weight of a wireless plant on board an airship varies from 200 to 450 pounds, according to the method used and also according to the desired range. Given the general conditions of the problem as just set forth, we will mention some points about the practical results which have been accomplished. It will be remembered that during the last military maneuvers in France, a series of tests was carried out with the military airship "Bayard-Clement," with Capt. Ferrié on board and operating the wireless plant. Although the full data are not yet made public, enough is known to give us encouragement in such work. It must be remembered that we have here a trial post in which every factor is reduced, size, weight, and power.

The current for the airship post is given by a storage battery, using ten cells of the automobile pattern. These give 20 volts with a maximum output of about 5 amperes. For producing the musical sparks, using a vibration period of 250 per second, there is employed a "vibrator" which is specially designed by Messrs. Bethenod and Ferrié, this being a kind of large tuning fork whose vibration is kept up by electromagnets. The sparks are protected by wire gauze covering so as to avoid igniting the gas. The total weight of the airship plant is 130 pounds. We now have some data as to the power and range. It was thought hitherto that we required to produce at least 2 kilowatts power on board the airship in order to have a range of 30 or 40 miles. However, it is found that signals sent from the "Bayard-Clement" could be very clearly heard on the ground when working at a range of 100 kilometers (62 miles) using a power below 50 watts (1/15th horse-power), and even probably very near 35 watts or but 1/20th horse-power.

### Wood Pulp

Wood fiber has come into general use as a substitute for the cotton rags and other materials formerly employed in the making of paper. This fiber is called pulp, having taken the name which used to be given to the cotton and linen fiber when it had been prepared by maceration for spreading into sheets of paper. The wood fiber used to be prepared, not so many years ago, by a wholly mechanical process. The blocks of wood were ground, or rasped off by action applied obliquely to the grain. The length of fiber depended partly upon the angle at which the block was held during this process.

In place of the old mode of obtaining wood pulp, chemical treatment of the wood is now in vogue. As formerly, the bark is stripped from the wood to secure fibers of uniform quality. All discolored or decayed parts are removed for the same reason. Then the wood is cut across the grain into thin chips, which are carried to the top of the mill and dropped into large drums about fourteen feet in diameter and twenty-four feet long.

The drums are made strong enough to bear a pressure of from seventy-five to two hundred pounds to the square inch. When a drum is packed full of chips it is filled with sulphuric acid and other chemicals. The wood is converted into a cotton-like product, which is then pressed dry and mashed. It is next mixed with water, rolled flat, and cut into shape for bundling. In this condition it is said to be made up of sixty per cent moisture and forty per cent fiber. In this shape it goes to the paper mill. Generally speaking, it is found better to pay the freight on the contained water than to cheapen the cost of transportation by pressing out the water, for the pulp packs hard when it is dry.

One cord of spruce wood is estimated to make twelve hundred pounds of dry fiber.

# The Bruceton Experimental Mine*

## Its Plan and Purpose

By George S. Rice, Chief Engineer Bureau of Mines

The explosibility of coal dust in air having been successfully demonstrated in the 100-foot gallery of the United States Bureau of Mines at Pittsburg, and in the longer galleries at Lievin, France, and Altofts, England, the next step in the investigation of coal dust explosions by each of the experiment stations was to determine the exact conditions under which such explosions took place. When these conditions were understood, tests of various preventive measures could be undertaken with some degree of precision. Prevention, or at least limitation, of explosions in mines was, of course, the real objective of the stations.

The gallery at Lievin, a short length of which was erected in 1908, was gradually lengthened to a distance of 820 feet; the one at Altofts, also erected in 1908, was about 950 feet long as originally laid out. In both these galleries the limitation of strength prevents safe loading with pure coal dust for more than a distance of 400 to 500 feet; on loading beyond this distance the galleries are sometimes ruptured. The managements of these stations have expressed the desirability of making tests of coal dust in longer and stronger galleries, since it is impossible to solve all the problems surrounding an explosive wave in the short distances now available; moreover, methods of limiting an explosion which were successful with a loading of coal dust for a length of 300 or 400 feet, would probably not be so with a longer loading or a larger explosion.

The Director of the Bureau of Mines, Dr. J. A. Holmes, and his technical staff at an early date appreciated these unavoidable limitations of a surface gallery, hence desired to obtain an underground gallery or mine opening, which would not only enable the tests to be made on a larger scale than is possible in external galleries, but in which experiments could be made under actual mining conditions. In such an underground gallery there would be no restriction as to the extent and violence resulting from explosion experiments, provided a suitable location was secured. Moreover, the methods of limiting and preventing explosions, the real objective of all such investigative work, could be tried out under real mining conditions.

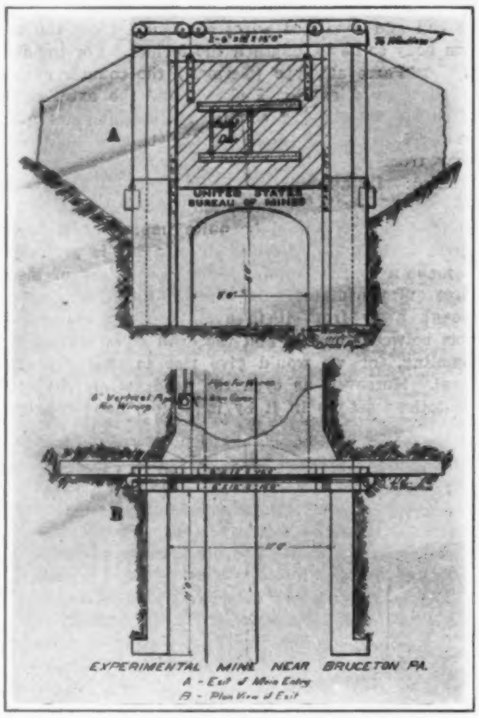
It was foreseen that the greatest difficulties in experimenting in an underground gallery would be:

(1) To obtain certain desired natural conditions.

(2) Having obtained those, to carry out and control the experiments in a scientific way, and be able to get complete records in the face of violent explosions.

After a long search a location for the experimental gallery, or mine, has been selected near Bruceton, Pa. From 2,500 to 3,000 feet of straight entry can be driven from the outcrop in the Pittsburg seam. In some of the mines operating in the seam, in the past, great explosions have occurred.

The entries will probably be either level or slightly rising, except for irregularities, so that there will be ravine close at hand water can be obtained for a boiler plant and fire protection. Natural gas for experimental purposes and for use in a gas incline engine and fan engine is obtained from a pipe line which passes a few hundred feet from the mouth of the mine. Finally, the situation is near enough to Pittsburg to allow convenient movement of the engineers and physicists between the testing station there and the mine. The location of the mine is twelve miles




ELEVATION AND PLAN VIEW OF ENTRANCE TO EXPERIMENTAL MINE

southwest of Pittsburg on the Wheeling division of the B. & O. Railroad. The coal and necessary surface surrounding the mouth of the mine has been obtained at a nominal rental from the Pittsburg Coal Company.

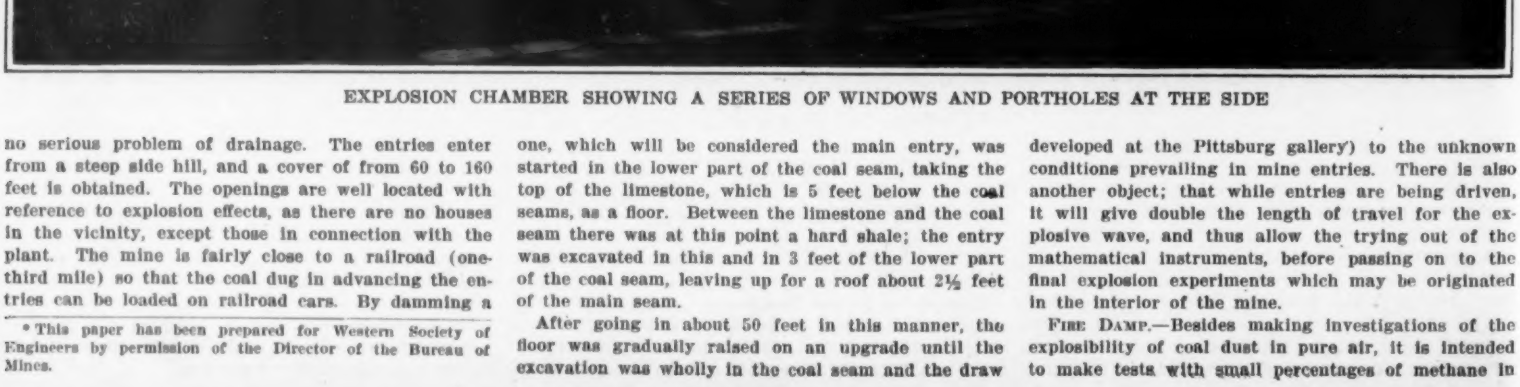
Progress and Development.—After a long-continued search for the best location, which would give the desired conditions, the present site was picked, and about the middle of December permission was obtained from the Secretary of the Interior and the director to proceed with the laying out of the mine. The surveys already having been made, the outcrop was uncovered, and two parallel entries with forty feet of pillar between them were started. At the time of writing this description these entries have been driven in under cover over 200 feet. The right-hand slate above it. The so-called "draw slate" is a soft shale or clay which comes down immediately on mining the coal. Above it, as is generally the case in the Pittsburg seam in this district, there is 1½ to 2 feet of so-called "roof coal," which is generally of poor quality and interspersed with layers of shale.

The parallel entry, which will be called the air course, was driven wholly in the coal seam. It is not intended to use the mouth of this entry in explosion tests. For normal driving, this air course will be the return, and ventilation will be obtained by a small fan driven by a gas engine located at the top of a small upcast shaft near the mouth of the air course. This shaft will be offset from the air course about six feet.

There will be another entrance to this air course joining it at about 150 feet from the mouth, and entering at an angle of about fifty-five degrees, on the opposite side from the main inlet. At the mouth of this side approach there will be placed a short length of concrete gallery with explosion doors, and beyond that a round steel gallery 120 feet long, 20 feet of which will consist of removable sections that can be rolled out of the way when it is desired to isolate the 100-foot gallery. This part will then be identical with the 100-foot steel gallery at the Pittsburg station, except in having a branch going off from it at a short distance from the inlet, to which a large reversible fan will be connected. The object of having this steel gallery, which is 6 feet 4 inches in diameter, separable from the mine is to render it possible to perform experiments similar to those conducted at Pittsburg. The gallery at Pittsburg is so continuously occupied with the testing of explosives, that systematic testing of coal dust cannot be undertaken in it. When the removable sections before mentioned have been rolled to one side and a steel door lowered in place to cover the connection into the air course, experiments can be conducted in the isolated gallery without interfering with operations in the mine.

Dust Tests in the Mines.—At the start it is intended that coal dust explosions will be originated in the steel gallery and the explosion will enter the air course through the branch, pass up same to the last open crosscut, through the latter into the main entry, and out to the mouth of same. The crosscuts will be driven on a circle tangent to the entries. This will require one forty-five degree turn and one semicircular turn of the explosion wave, a condition which seems to cause no obstacle in a real mine explosion, nor does it cause difficulty in the Altofts gallery. The records of experiments in that gallery show that on the return side, that is, toward the exhaust fan, the dust, carried by the air current and the advance compression wave of the explosion, has been inflamed and the flame has passed around a number or all of the five right-angled turns in that gallery.

The purpose of this method of initiating explosions in the outside gallery of the experimental mine is to proceed from the known conditions in the gallery (as



EXPLOSION CHAMBER SHOWING A SERIES OF WINDOWS AND PORTHOLES AT THE SIDE

no serious problem of drainage. The entries enter from a steep side hill, and a cover of from 60 to 160 feet is obtained. The openings are well located with reference to explosion effects, as there are no houses in the vicinity, except those in connection with the plant. The mine is fairly close to a railroad (one-third mile) so that the coal dug in advancing the entries can be loaded on railroad cars. By damming a

* This paper has been prepared for Western Society of Engineers by permission of the Director of the Bureau of Mines.

one, which will be considered the main entry, was started in the lower part of the coal seam, taking the top of the limestone, which is 5 feet below the coal seams, as a floor. Between the limestone and the coal seam there was at this point a hard shale; the entry was excavated in this and in 3 feet of the lower part of the coal seam, leaving up for a roof about 2½ feet of the main seam.

After going in about 50 feet in this manner, the floor was gradually raised on an upgrade until the excavation was wholly in the coal seam and the draw developed at the Pittsburg gallery) to the unknown conditions prevailing in mine entries. There is also another object; that while entries are being driven, it will give double the length of travel for the explosive wave, and thus allow the trying out of the mathematical instruments, before passing on to the final explosion experiments which may be originated in the interior of the mine.

Fire Damp.—Besides making investigations of the explosibility of coal dust in pure air, it is intended to make tests with small percentages of methane in

the air. It is generally recognized that a very slight amount of methane, even as low as one-half per cent, may increase the chance of ignition of coal dust and more widely extend an explosion that has once been started.

The location of the experimental mine is fortunate in having a natural gas-pipe line near it. This line takes gas from some gas wells in the same ravine. It is intended to take a branch from this gas main for use in a gas engine hoist and in a gas engine for driving a small ventilating fan. It will also be used for

ENTRANCE TO THE EXPERIMENTAL MINE NEAR BRUCETON, PA.

the purpose above indicated, of introducing when desired small quantities of gas into the mine.

Natural gas has very nearly the same composition as the marsh gas of the coal seams, the difference being that in addition to the methane ($CH_4$) there is from 10 to 15 per cent of ethane ($C_2H_6$). This slightly varies the proportion of the mixture of air for its combustion, but the difference for practical purposes is negligible.

The gas will be piped to certain points, and by a system of mixing with the ventilating current will be carried through in whatever proportions may be required; approximate percentages will be determined through meter measurements, and precise determinations by sampling the air and gas mixture and analyzing. It is considered that this line of investigation of the effect of small percentages of methane is most important, and the need for it has been expressed by foreign critics of coal dust experimentation now being carried on.

CONCRETE LINING.—It is anticipated that great explosive force will be developed at the mouth of the main gallery; hence it is intended that the timbering which is now in place shall be supported by reinforced concrete walls and arching. The latter will present a smooth surface to the explosive wave and thus prevent great falls at the mouth of the mine, the occurrence of which would lead to heavy expense and delay in clearing up after each experiment.

It is the plan to concrete the approach leading from the steel gallery to the air course, and it may become necessary to concrete between this connection to the mouth of the air course, although it is not intended to load that portion of the air course with coal dust. It is expected that the explosion wave entering from the gallery entrance will not have gained sufficient momentum at the junction with the air course to break down doors or stoppings erected between that point and the mouth of the air course, but will be deflected into the air course toward the face.

METHOD OF DRIVING ENTRIES.—The method of driving entries is the usual one employed in the Pittsburg coal seam. The coal is undercut and shot down with explosives, which in this case are of the "permissible" type, electrically fired. The coal is loaded on pit cars, which are hauled by mules to the mouth of the mine, thence over an outside tramway with slight descending grade, to the head of a rope incline. Trips of cars are lowered, by the hoist under brake, to a trestle and tipple located on a siding of the B. & O. Railroad.

BUILDINGS AND APPARATUS.—It is necessary to have a considerable number of buildings; these are now under construction. There will be a boiler house with boiler to furnish steam for the several engines, including the fan engine. A crusher and grinder house will be necessary to grind up the dust for the experiments; as much as four tons will be necessary when the mine is fully developed. There will be a blacksmith shop containing small equipment for the necessary repairs and an engine house for the incline engine. There will be a combined office and observation room for observations and the starting of explosions, in connection with which there will be a small laboratory for field analyses of gas and mine air samples. Several small buildings, including a stable for the mules, have already been constructed.

VENTILATING FAN.—The ventilating fan for the experiments must be of such size as to create all the conditions which may surround an explosion in a mine. It is desirable to obtain high velocity in restricted areas, say 1,500 feet per minute over a considerable distance. A capacity of 80,000 cubic feet per minute at a pressure of two inches water gage and 15,000 cubic feet per minute at a pressure of six inches water gage is specified and has been guaranteed by the builders. The fan is made reversible, so that experiments may be conducted with dust explosions going against the air current as well as dust explosions going with the air current. The Altofts gallery fan is not reversible, and the explosion portion of the gallery is at the intake end.

PRESSURE AND RECORDING INSTRUMENTS.—The important objects of the experiments are to obtain the speed of the explosion as indicated both by pressure and by flame; the variation in pressures at different points along the course of the explosion; the temperatures, and the samples of the gases immediately preceding the inflammation of the dust or gas and immediately following the inflammation at a given point. Such experiments will require apparatus of an extremely sensitive nature.

A set similar to those used in the Altofts gallery has been purchased from the Cambridge Scientific Instrument Company of England. These were designed primarily for external galleries, but it is believed there will be no serious difficulty in arranging them in steel plate boxes sunk into the coal rib. It may be found necessary to design new and additional apparatus.

An important point in the use of the recording instruments is their driving, also the making and breaking of electric circuits. To connect these instruments with the outside will require the wiring to be done in such a way that it will not be torn out by the explosions. It is proposed to place the wiring in pipes placed in a groove in the coal rib and at the mouth of the mine; these pipes will be set in concrete, but arranged with suitable boxes at short distances apart, so that the wires may be readily accessible.

It is evident that to make the wires safe under the enormous pressures which are expected, which may run up to several hundred pounds or more per square inch, will need great care. To obtain the currents for the instruments will require a very steady-running generator engine set. It is expected to obtain a set which will be sufficiently large to allow some lighting with incandescent lamps in and around the mine.

LIMITING OR PREVENTING EXPLOSIONS.—The real importance of the experiments is not the mere study of explosion waves, although of great scientific interest,

BOY MINER AND HIS MULE, WHO WERE SAVED TOGETHER FROM A MINE EXPLOSION

but to study methods for preventing or limiting explosions. It is, therefore, proposed to experiment with all the important methods that have been suggested up to date, among which may be briefly recited, watering by water sprays, by exhaust steam sprays, and by deliquescent salts (Calcium chloride) and by rock and shale dust in various ways. It is believed these experiments tried out in a mine on a sufficiently large scale can effectually demonstrate the relative efficiency of the various methods.

EXPLOSIVES.—A secondary purpose of the experimental mine, and by no means an unimportant one, is the study of explosives which have been placed on the permissible list for use in gaseous and dusty coal mines—testing them under actual working conditions in coal.

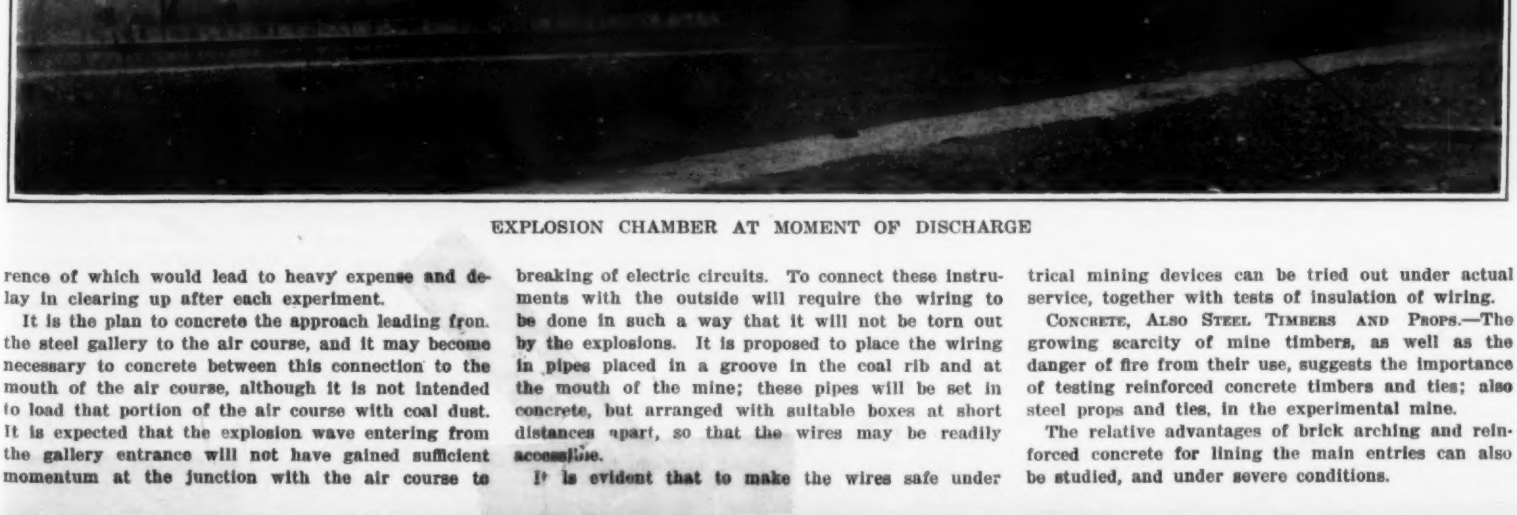
DUST PRODUCTION.—Another purpose to which the experimental mine can be put is the study of the relative production of inflammable dust by different types of machines which undercut or shear the coal.

GASOLINE LOCOMOTIVES.—Still another purpose is the testing out under mine conditions of gasoline motors to determine the safety of the apparatus in actual use and the degree to which the air may be vitiated by the exhaust gases.

ELECTRICAL DEVICES.—It is probable that many electrical mining devices can be tried out under actual service, together with tests of insulation of wiring.

CONCRETE, ALSO STEEL TIMBERS AND PROPS.—The growing scarcity of mine timbers, as well as the danger of fire from their use, suggests the importance of testing reinforced concrete timbers and ties; also steel props and ties, in the experimental mine.

The relative advantages of brick arching and reinforced concrete for lining the main entries can also be studied, and under severe conditions.



EXPLOSION CHAMBER AT MOMENT OF DISCHARGE

# The Production of Light by Living Organisms*

## The Chemistry of Biophotogenesis

By F. Alex. McDermont,

Division of Chemistry, Hygienic Laboratory, U. S. Public Health and Marine Hospital Service, Washington, D. C.

The term "Biophotogenesis," in its complete sense of the production of light by living organisms, covers a group of phenomena accompanying the vital processes in a wide range of animal and vegetable forms. The fireflies (*Lampyridæ*) are to us the commonest and most brilliant of these biophotogenic forms.

During the summer of 1909, the writer was associated with Professor Joseph H. Kastle, of the University of Virginia (then Chief of the Division of Chemistry of the Hygienic Laboratory), in a study of the effect of various chemical reagents on the luminous tissue of the firefly common in this locality (*Photinus pyralis* Linn.), and the results of our work are contained in a paper entitled "Some Observations on the Production of Light by the Firefly," in the *American Journal of Physiology*, Vol. 27, pp. 122-151. At the time this work was started, Professor Kastle was engaged in the preparation of his monograph on "The Oxidases and Other Oxygen-Catalysts Concerned in Biological Oxidations" (Bulletin No. 59, Hygienic Laboratory), and a latent interest in this subject was awakened by the recurrence of references to the claim of Dubois that the photogenic process in organisms involves the action of an oxidizing ferment or oxidase, to which this investigator had given the name "Luciferase." Professor Kastle's prior observations on this point had led him to believe that no oxidase was present, but that peroxidase and catalase were present; he found that aqueous extracts of the luminous tissue of the common firefly failed to turn tincture of guaiacum blue, except in the presence of hydrogen peroxide, and the bluing in the presence of the latter was accompanied by the rapid disengagement of oxygen.

This insect, *Photinus pyralis* Linnæus, is the one which is so very common in our parks and lawns during the summer. It is a species of the family *Lampyridæ* (fireflies, lightning-bugs), of the genus *Coleoptera* (beetles). The luminous apparatus of the male insect—the more commonly seen of the sexes—occupies the entire ventral surfaces of the two abdominal segments next to the last, and a portion of the preceding segment. That of the female is a small rectangular area on the third abdominal segment from the last; both sexes have also two very small points of luminous tissue on the last abdominal segment.

The color of the light of this insect is generally stated to be yellow or yellowish-green; some of the other local species exhibit a light of a slightly different tone. The light of the *pyralis* has recently been made the subject of a very interesting spectrophotographic study by Drs. Ives and Coblentz, at the Bureau of Standards (*Bulletin of the Bureau of Standards*, Vol. 6, pp. 321-336). These observers found the light of this insect to resemble very closely the light of the Cuban cucuyo (*Pyrophorus noctilucus* Linn.), as studied and described by the late Professor S. P. Langley and Professor F. W. Very, nearly twenty years ago. ("The Cheapest Form of Light," Miscellaneous Collections, Smithsonian Institution, 1901; reprint.) Briefly, the spectrum of the light of *Photinus pyralis* consists of a "structureless, unsymmetrical band" in the red, yellow and lower blue portions of the visible spectrum, with a maximum at that portion having the greatest illuminating effect with the minimum of actinic and thermal effects. It gives no hint of continuation in the infra-red or ultra-violet portions of spectrum. It seems probable that the light of most luminous insects is essentially similar to that of the *pyralis*; two other species of Lampyridæ that I have examined have lights showing spectra of even more limited range than that of the *pyralis*, and in both of these species the color of the light to the eye is more greenish than that of the commoner insect. However, Mr. H. S. Barber, of the U. S. National Museum (Proceedings of the Washington Entomological Society, Vol. 9, pp. 41-43) and other observers have reported that various species of tropical *Phengodini* (a group of beetles probably closely allied to the Lampyridæ) give a red light from a photogenic organ in the head; no spectroscopic studies of this light have been made. Max Trautz ("Studien über Chemilumineszenz," *Zeitschrift für physikalische Chemie*, Vol. 53, pp. 1-111) states that the spectrum of the light produced by the oxidation of pyrogallol by means of thirty per cent. hydrogen peroxide in the presence of formaldehyde, extends from the red to the lower blue, and therefore covers very nearly the same spectral area as that of the light of the firefly. The spectrum of the light of glowing phosphorous also appears to give a spectrum lying within this same area, though of less extent than that of the firefly. Although a little ahead of the subject, I will state here that the light produced by moistening with 3 per cent. hydrogen peroxide solution the luminous tissue of the firefly which has been desiccated over sulphuric acid in an atmosphere of hydrogen, gives a spectrum of very limited range, extending from the orange to the yellow-green. The spectrum of the light produced by the photogenic bacteria is also of less range than that of the *Lampyridæ*.

It need scarcely be said that the light of the firefly affects the photographic plate; obviously spectrophotographic studies could not otherwise have been made upon it. Dubois has taken photographs by means of the light of the photogenic bacteria and of the cucuyo. In 1896 Muraoka (*Annalen der Chemie und Physik*, Vol. 295, pp. 773-781) announced that he had proved the penetration of metal films by means of the light of the firefly, in a manner similar to that of the X-rays. This was very puzzling to physicists, in view of the known limited range of the light, and the fact that it gave no other evidence of containing ultra-violet or penetrating rays. I have experimented with the local insect (*Photinus pyralis*), and have failed to find the least evidence of penetration of thin sheet copper, aluminium foil, or the ordinary black paper with which X-ray plates are wrapped. Some explanation of Muraoka's rather extraordinary results has been offered, based upon some more or less vague bacterial or vapor influence, but when we consider that his results were published only a little while after the discovery of the X-ray, it seems possible that Muraoka was just a little over-enthusiastic.

Professor Kastle and the writer tried the effect of a large number of chemical substances upon the live insect, the freshly detached luminous organ, and the luminous tissue which had been dried in hydrogen, and for these in detail the reader is referred to the paper in the *American Journal of Physiology*, *ante*. A great deal of work had already been done along similar lines, some of it dating back to the times of Reaumur and Spallanzani; Ehrenberg, Milne-Edwards and Pflüger have in turn reviewed this literature quite thoroughly.

Some of our results, however, seem worthy of special attention. Taking first the live insect: Injections of solutions of the metallic nitrates, of strychnin and of adrenalin, caused the emission of light. Immersion of the insect in methyl and ethyl alcohols, in ether and in chloroform, resulted in the production of light. Immersion in pure oxygen appeared to stimulate the photogenic function somewhat, but not as much as might have been expected. Immersion in nitrous oxide caused a considerable increase in the intensity of the light. In the cases of injection and immersion in liquids, the reagents kill the insect, but not until they have caused light-emission. Nitrous oxide narcotizes the insect, but in the air it recovers again. Hydrocyanic acid and cyanogen kill the insect, of course, but not until they have caused the emission of light. The luminous organ of one of the local species of *Lampyridæ* has been observed to glow in the mixture of air and prussic acid in the cyanide killing-bottle for over an hour, long after the actual death of the insect. Ammonia-water causes the evolution of light, either by injection or immersion; Watasé is authority for the statement that if a tissue suspected of being luminous refuses to give light with any other stimulus, it will, if a true photogenic tissue, glow on moistening with dilute ammonia-water. The injection of 3 per cent. hydrogen peroxide solution also caused the evolution of light.

With the freshly detached luminous segments, the most notable results were obtained with the vapors of methyl and ethyl alcohols, carbon tetrachloride and bisulphide, and mononitrobenzene, acting in the presence of air. All of these reagents caused light-emission and the light given out was not the continuous faint glow frequently the result of weak chemical stimuli, but was accompanied by a series of distinct flashes or pulsations of light, similar to the normal flashes of the insect. With the detached organ, the effect of powerful poisons was in almost every instance to produce the evolution of light, sometimes faint and of short duration, but definite. As examples of poisons acting thus may be cited hydrofluoric acid, iodin cyanide and bromine.

The interesting fact that the photogenic tissue of luminous life-forms preserves after desiccation the power to evolve light on the application of water in the presence of air or oxygen, has long been known, and it at once suggests other known instances of the preservation of biologic activity by drying, as exemplified by the yeasts and ferments. By drying the photogenic tissue of *Photinus pyralis* over sulphuric acid in hydrogen or a hydrogen-vacuum, we have prepared dry material which has retained its photogenic activity apparently without loss, when kept in sealed tubes, for over thirteen months; indeed, there seems to be no good reason why, under these circumstances, it should deteriorate. In its conduct toward various chemical substances, the dried tissue, after moistening, does not differ essentially from the live insect or the freshly detached luminous organ. It glows on moistening in the air, somewhat brighter on moistening in oxygen, and but dimly or not at all when moistened in nitrogen, hydrogen and carbon dioxide. Moistened with 3 per cent. hydrogen peroxide instead of water, the dried tissue produces a much brighter light than with water alone, accompanied by the decomposition of the peroxide. The spectrum of the light thus produced has already been referred to.

Thus far, one substance alone has conducted itself as a positive inhibitor of the photogenic function. This is sulphur dioxide. Carradori observed this fact with the *Luciola italica* over one hundred years ago. Dubois has made a similar observation with regard to the cucuyo. The live insect, the freshly detached luminous organ, and the dried tissue, placed in this gas, all fail to glow, or glow but weakly and momentarily and are dead to all other stimuli when removed from it. As a rule even those substances which tend to poison the luminous tissue, caused the evolution of a dim light at first, but not so with sulphur dioxide in the majority of cases in which we used it.

Mechanical stimuli, such as friction and percussion, and physical stimuli, such as electricity, heat and light, also cause the production of light by the luminous organs of the firefly, whether attached to the living insect or detached. The effects of various temperatures and of electric discharges of various strengths have been extensively studied by other observers. Transferring the detached luminous organs from one gas to another, even though one or both be chemically neutral, may cause light-production, apparently due to some osmotic effect. Currents of air and other gases exert an effect on these detached organs, which Professor Kastle has compared to the effect of air-currents on the strychninized frog. It is obvious from these facts that the luminous tissue is one of great irritability.

Our knowledge of the chemical processes involved in biophotogenesis is very meager. The luminous organ of *Photinus pyralis*, in common with those of the other *Lampyridæ* which have been studied, consists of two layers of cells, under the outer transparent chitin. These layers of cells are penetrated by numberless tracheæ, the ends of which appear to be connected by a network of very fine tracheoles, the whole system resembling the finer veining of a leaf. On the inner surface of the organ these tracheæ unite to form larger passages. It is practically certain that during the life of the insect these tracheæ are filled with air. Of the two cell layers, the outer consists of a mass of some special type of nucleated cell, of unknown nature, penetrated by the aerophore cylinders, while the inner layer is composed of guanine and sodium or ammonium urate, and probably serves as a reflector. These guanine reflecting layers have also been found in the luminous organs of various fish and cephalopods, whose names I will not attempt to inflict on the readers of this paper. The luminous apparatus of these fish and other of the higher sea-forms is quite highly developed, there frequently being a definite lens with a light-producing body back of it, and behind this a guanin reflector, sometimes with a roughly parabolic section.

It is pretty well established that all photogenic organisms require at least two constant chemical factors in order to exhibit their luminous property, viz., the presence of oxygen and of moisture. Bischoff has claimed that the photogenic process in the luminous rhizomorphs (mycelia) is accompanied by the absorption of oxygen and the evolution of carbon dioxide, and other observers have made similar

* From a paper read before the Chemical Society of Washington, October 13th, 1910.

claims for other cases of biophotogenesis; my own observations tend to support these claims, but as yet the evidence is somewhat too meager, at least so far as the evolution of carbon dioxide is concerned. Dubois's theory assumes the oxidation of a substance of unknown composition, to which he has given the name "Luciferine," through the agency of the oxidase "Luciferase." Until more definite data are at hand, it would seem that this theory requires some caution in acceptance. The facts so far as known certainly present some analogy to other known biologic processes, and it is not at all impossible that his explanation may be correct. Watasé expresses the view that in *Noctiluca miliaris* and other simple luminous forms, the "phosphorescence" is associated with the contractility of protoplasm, as a potential property of all protoplasm, whether exhibited or not, and he rather leaves the reader with the impression that he believes that the particles of food-materials are actually burned in the living tissues with the production of an incandescent temperature. (*Protoplasmic Contractility and Phosphorescence*, Biologic Lectures, Wood's Hole, Mass., 1898.) Jousset de Bellesme, in 1880 (*Comptes Rendus de la Academie des Sciences*, Paris), stated that he believed the light to be due to the spontaneous combustion of phosphine, liberated by the decomposition of protoplasm, and Sir Humphry Davy noted that Lavoisier held a similar view. The nature of the substance consumed in this biologic oxidation—the *Noctilucin* of Phipson, the *Luciferine* of Dubois, and the *Photogene* of Molisch—has been variously regarded by different authors. Many seem to have regarded it as a fat or a fat-like substance; Phipson, who apparently isolated and analyzed a culture of photogenic bacteria, concluded that it contained nitrogen; Kölliker and Macaire believed it to be an albuminous body. Embryologically, it appears to be an extension of the fat-layer. Various observers have found the urates and phosphates of ammonium, sodium, potassium and calcium in the luminous tissue and its ash. Dubois at one time seems to have rejected the oxidation theory and to have believed that the light was due to the spontaneous crystallization of ammonium urate. All attempts to definitely extract and analyze the active substance have failed. When the luminous organs are treated with alcohol or ether in an atmosphere of hydrogen, the liquid acquires a yellow color, but no light-emission occurs when it is exposed to the air or treated with hydrogen peroxide. Lecithin does seem to exist in the insect in small amount.

An interesting circumstance in this connection is the existence in certain luminous organisms of a substance whose solutions exhibit a brilliant blue fluorescence. Dubois found this substance in the cucuyo, and Dr. Coblentz has found it in *Photinus pyralis*, *Photinus corruscus*, and *Photuris pennsylvanica*. I have found it in *Photinus scintillans* also. Dubois regarded the substance he extracted from the cucuyo as analogous to esculin (a glucoside which is present in the bark of the horse-chestnut, and whose solutions possess a blue fluorescence), and he regarded it as essential to the photogenic process, attributing to the actinic properties of the blue rays in its fluorescent light the actinic power of the emitted light of the insect. Personally, I am inclined to regard the fluorescence simply as an incidental property dependent on the structure of some compound frequently met with in insects of this nature, much as Jordan regards the fluorescent pigment of *Bacillus fluorescens liquefaciens*. Fluorescent extracts of the *pyralis* are produced by extraction with alcohol, ether and water, but not by chloroform, benzene, or carbon tetrachloride. The fluorescent material is not precipitated by lead acetate, mercuric chloride, ammonium sulphate, nor chlorplatinic acid. It appears to be a solid at ordinary temperatures, though as emitted by the insect it is contained in a sticky exudation, which soon hardens in the air.

We cannot say now what possibilities lie before us in the discovery of the "secret of the firefly," particularly as to the kind of "oil" he uses in his little lamp. Perhaps it will be discovered and turned to practical account. The emitted light of the firefly is far from being a good light for general illumination, in spite of its luminous efficiency of 96.5 per cent., on account of the very limited range of color effects possible under it. A single firefly has been variously estimated to give from 1-840 to 1-1600 of a candle power, so we would need quite a high "firefly power" to light our homes and streets by biophotogenic light. There are still many gaps in our knowledge of this interesting subject, in spite of the large amount of work that has already been done, but one by one we hope to close these up and discover the secret of "The Cheapest Form of Light."

# The Camphor Industry*

## Japanese and Formosa Methods

AMPHOR, produced from the camphor tree (*Cinnamomum camphora*) has a large use not only as a drug but more especially in the celluloid industry, where it is used in the transformation of cellulose nitrate to celluloid. It is used extensively in the manufacture of smokeless powder, in the making of substitute leathers, and generally in the plastic pyroxylin industry.

Imports of crude camphor into the United States for the fiscal year ending June 30th, 1910, were 3,026,648 pounds, valued at $921,926; refined and synthetic camphors added to this 477,269 pounds, valued at $179,965.

The sources of camphor are practically all foreign. Experimental plantations in the United States will not be ready for production within three or four years, and while the indications are all toward the success of this venture, the commercial production of camphor on a large scale in this country is not to be expected in the immediate future.

At present, barring the production of synthetic camphor, our sources of supply are the East Indian Islands, Borneo, Sumatra, and particularly Japan and Formosa. In Japan and Formosa the camphor trade is a government monopoly. All camphor and camphor oil produced must be sold to the monopoly bureau. The amount of camphor to be placed on the market, the price to the producer, and to the vendee, are fixed by the government.

The privilege of engaging in the industry is granted by the government to individuals and companies on application. The applicant is required to furnish some evidence of his financial standing. A certain territory is allotted to each operator, and he must confine his operations to that tract.

The trees are found only in mountainous districts. In Formosa they are in the interior, where the collection of camphor is rendered hazardous by the presence of the head-hunting tribes which infest the region. Conditions have improved in this respect since the Japanese occupation of the island, owing largely to the conciliatory policy adopted by the Japanese officials, yet in 1909 there were 96 workmen killed by the savages. Owing to the danger of attacks by the tribes wages are high, being 90 cents gold for a native and $2 for a Japanese.

The condition and extent of the forests have been variously estimated. It is sometimes stated that the camphor forests are inexhaustible. Again, it is estimated that the Formosan forests will be exhausted in twenty years. As a matter of fact the truth is between these limits; perhaps forty-five years of production at the present rate will use up all the trees now workable.

However, the government and private individuals have been planting young trees. About 15,000,000 trees have been set out since 1901, and with a continuance of the policy of yearly planting it is probable that there will always be a sufficient supply of producing trees.

All camphor trees do not produce camphor. In Borneo, for instance, it is said that only one tree out of 100 bears camphor crystals. The lumber from the trees is valuable, however, and is much used for building, as it is less subject to the ravages of the white ant than most woods. If the camphor odor is quite strong the boards may be used for insect-proof boxes.

In selecting the trees which are to be treated to extract the camphor there is nothing in the outside appearance to guide the searcher. Chips are taken from the trees, and if the camphor odor is absent the tree is not cut. The trees sometimes are 3 or 4 feet in diameter and 180 feet tall. If the odor from the chips is sufficiently strong a search is made over the tree for a flaw in which the camphor gum may have collected. The tree is cut off below the flaw and the wood split away in order to find the deposit. The flaw may be from 4 to 6 feet long and may contain up to 14 pounds, though 7 pounds would be above the average.

In Japan and Formosa the body of the tree which contains camphor is cut into chips by the workers, who use for this purpose a chisel-like knife. The finer the chips the more suitable they are for distillation. They may be taken from trunk, limbs, roots, or twigs. The chips are now distilled in an apparatus of native manufacture which is crude, but better than mechanical devices which have been imported from Europe.

Over a fireplace is a pan filled with water. Above the pan is a very tight circular wooden retort, about 3 feet in diameter at the bottom and 1 foot at the top, and 5 feet high.

This retort is filled through an opening in the top with the camphor wood chips. The opening is then closed by a double lid, and earth banked around the lower section of the retort prevents the escape of the camphor fumes. Just above the water pan are thin slats of perforated bamboo, through the apertures of which steam passes into the chips above, extracting the camphor. Near the top of the retort are two bamboo pipes, through which the vapors are conducted to a cooling box about 10 feet distant. This cooling box is divided into two compartments; the lower is filled with cool water, and the upper contains a wooden screen, upon which the camphor crystallizes. Connected with the cooling box is another of exactly similar description, called the crystallization box. Both are immersed in water, which hastens the process of crystallization. Distillation requires about 24 hours. The chips are then removed through an opening in the lower section of the retort.

The two products of the distillation are crude camphor and camphor oil. The camphor is crystallized on the screens of the boxes. The oil is caught in leads and also skimmed from the water in the cooling boxes.

The camphor and camphor oil thus obtained are shipped to Kobe, Japan, where the camphor oil is further treated. It is heated in small cast iron stills and the fraction having a specific gravity 0.825 to 0.920, which contains 45 to 55 per cent of camphor, is cooled to allow the camphor to crystallize out. When ready, the crude camphor is drained out of the oil by filtering through cloth bags.

After draining for a few days this product is packed in tubs, and after some months gives by rearrangement, crystals quite as large and firm as those of the crude camphor produced from the wood.

These two grades produced from the wood and from camphor oil when mixed at the monopoly plants constitute what is known as grade "B," or commercial crude camphor. This is used by the American trade.

In the government refineries the "B" grade is somewhat purified, and yields the "BB" grade, which is exported along with the "B" grade to European markets. This is also the grade supplied to the seven companies licensed by the government for refining. They sublime the camphor, producing a clear block of pure camphor.

There are two kinds of camphor on the market—the Japanese $C_{10}H_{16}O$, or ordinary camphor, and Borneo camphor obtained from *Dryobalanops camphora*, $C_{10}H_{17}OH$. The latter is more expensive, owing to the demands of the Chinese trade, and is seldom in American or European markets. It can, however, be produced by reduction of ordinary camphor. The odor of Borneo camphor or borneol is much like that of ordinary camphor, but it has in addition a somewhat peppery smell.

The tremendous increase in the use of camphor caused an increase in exports from Japan and Formosa of from 620,000 pounds in 1868 to 8,427,000 in 1907, and at the same time a rise in price of from $16.42 to $168.50 per 220 pounds. Owing to the extraordinary prices, industrial chemists were led to investigate the question of producing synthetic camphor, with such success that in 1905 and following they were able to compete with the natural product. In 1908 the effect upon the market of synthetic camphor was such as to reduce imports of natural camphor nearly one-half as compared with 1907.

Immediately following, however, Japan and Formosa were able to quote prices so low that practically all of the firms manufacturing synthetic camphor have been forced to discontinue operations, and natural camphor not only has regained its old market, but is striving with success to find new ones, mainly in the extreme East. It is true, however, that the rapidly increasing price of turpentine may have had something to do with this condition of affairs, and also that in a few cases, notably that of the Chemische Fabrik a. A. vorm. A. Schering of Berlin, it seems possible to make the artificial product and keep its market under present conditions.

Many patents have been taken out covering processes for the formation of synthetic camphor, but all are attempted improvements on the one original discovery—i. e., that pinene, a hydrocarbon in turpentine, could be converted.

The methods for effecting the transformation are various, but all follow practically the same line. Pinene, $C_{10}H_{16}$, is treated with HCl or oxalic acid. In the first case the pinene hydrochloride is heated under pressure with acetate of lead in acetic acid, causing

* From U. S. Consular Report.

the formation of camphene, which has the same empirical formula as pinene, $C_{10}H_{16}$, but is of a different structure, and is therefore easily oxidized to camphor, potassium permanganate being used to produce the change.

In the second case, where oxalic acid is used, instead of pinene hydrochloride, we have a mixture of camphor, pinyl formate and pinyl oxalate. This is washed with water, and the oxalate and formate are saponified, whereby camphor and borneol are formed. The mixture is distilled and the borneol is oxidized by means of chromic acid to camphor. Other modifications are very numerous, over 200 patents having been taken out, but these two examples are sufficient to show the general lines on which the synthesis is carried out.

The firm of A. Schering of Berlin, which has been able to continue the manufacture, does not disclose its special methods and laboratory equipment. It is generally understood that it has followed along the lines of original German patents, the second case previously mentioned. How much further it can follow a downward move in prices is not known, but competent persons feel that the limit will soon be reached.

The establishment of the industry in the United States might not be so difficult. The obtaining of turpentine is an easy matter, and while not considered so good as the French turpentine, the American ranks next in favor with manufacturers.

Another fact in favor of American manufacturers would be the import duty of 6 cents per pound which is levied on both refined and synthetic camphor.

# A Quarter Century of Experimental Embryology

## Wilhelm Roux and His Work

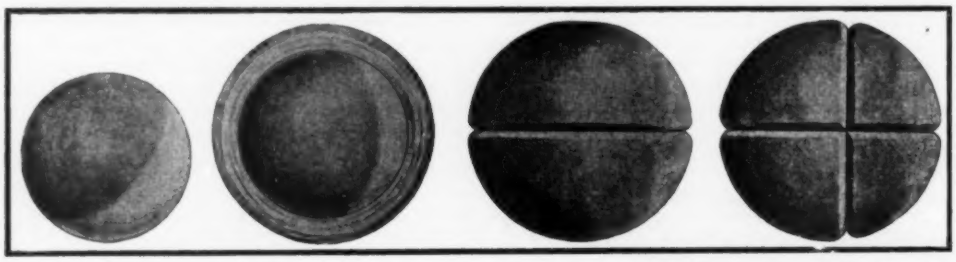
Twenty-five years have passed since Wilhelm Roux published his first contribution to the mechanics of evolution, in which he indicated an effective method of analyzing the complex process by which an individual organism is developed, and described a series of preliminary experiments. He had previously published observations and a theory of the "functional adaptation" produced in organs by exercise in performing special functions.

PROF. WILHELM ROUX

Wilhelm Roux, who is now professor of anatomy at Halle, received on his sixtieth birthday, June 9th, 1910, an honorary address, signed by more than eighty men of science.

The following sketch of the new branch of science by Prof. Albert Halle in the *Illustrite Zeitung* is based chiefly on its founder's own work.

"Experimental embryology, or the mechanics of evolution, deals with the development of the complex living organism from the apparently simple egg. The only effective method of studying the causal factors of this development is found in selective experiment, guided by a mental analysis of the complex phenomena. Roux began by determining the epoch of the first conspicuous change in the egg, the establishment of the principal axes of the embryo, and subsequently succeeded in discovering the factors which normally produce this change. "Some of the initial stages in the development of a frog embryo are shown in Figs. 1 to 5. Roux first proved by experiment that, in normal development, the deep furrow which appears soon after fertilization, and divides the egg into two equal segments (Fig. 3), subsequently becomes the plane of symmetry between the right and left halves of the embryo (Fig. 5). The next question was, whether or not the future position of the plane of symmetry is indicated in the egg, before fertilization.



1. Side view 2. Top view 3. First furrow 4. Second furrow
of egg soon after fertilization.

Figs. 1 to 4.—Initial Stages of Development of a Frog's Egg

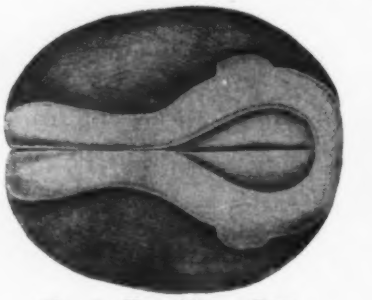
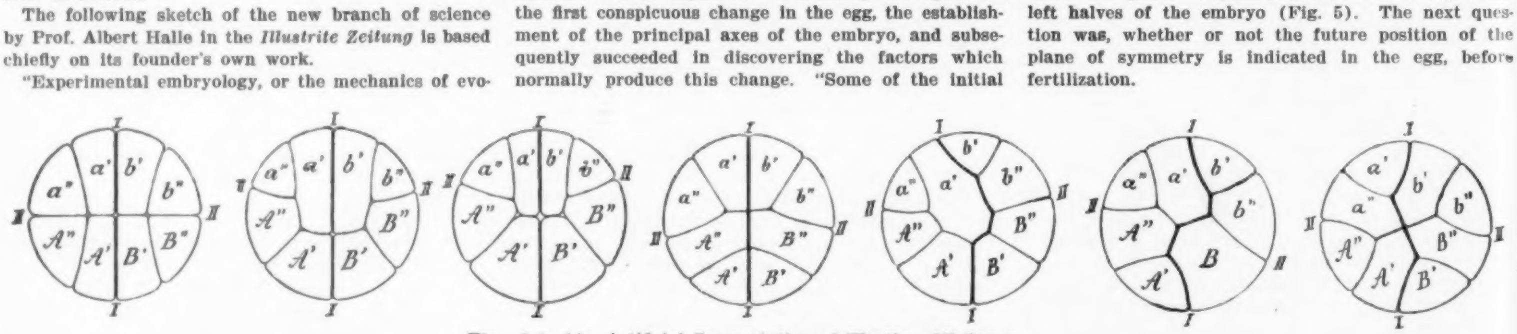
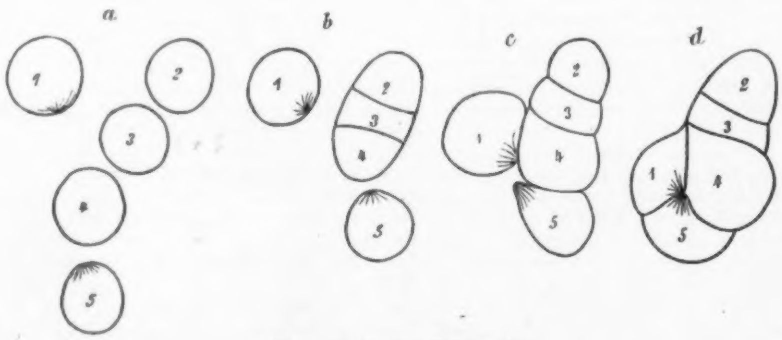


Fig. 5.—Very Young Frog Embryo

Figs. 6 and 7.—Development of Brain and Spinal Cord



Figs. 8 to 14.—Artificial Segmentation of Floating Oil Drops



Figs. 15 to 18.—Cytotropism

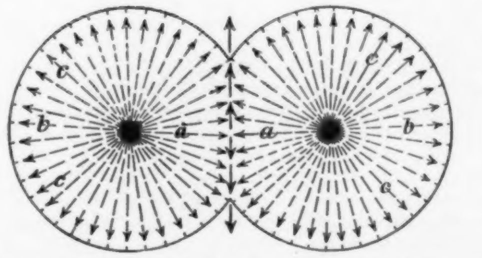


Fig. 25.—Apparent Attraction of Drops of Choloroform

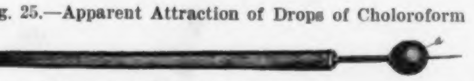


Fig. 26.—Cell-destroying Needle With Heated Brass Ball

Figs. 19 to 24.—Another Example of Cytotropism, or Elective Affinity of Cells

"The egg of the frog (Figs. 1 and 2) is composed of a dark and a light hemisphere. The material of the dark hemisphere is employed chiefly in forming the embryo, while the light hemisphere consists principally of food for the growing embryo. These foodstuffs are heavier than the contents of the dark hemisphere. Shortly after fertilization, when the egg has become free to rotate in the rim by which it is attached to its environment (Fig. 2), it turns so as to bring the dark hemisphere above the rim, and the light hemisphere below. In the egg of the green water frog this adjustment is not made accurately, but the division between the light and dark hemispheres is considerably inclined, as is shown by the

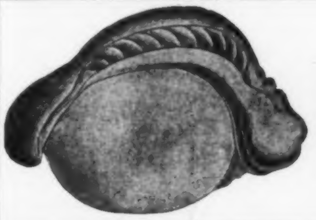


Fig. 27.—Embryo Developed From Left Half of Frog's Egg

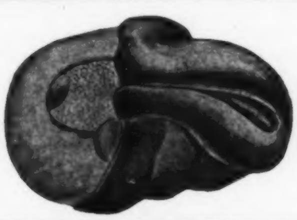


Fig. 28.—Embryo Developed From Front Half of Frog's Egg

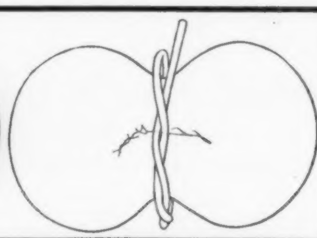


Fig. 29.—Salamander Egg Constricted to Form a Double Monster

side view (Fig. 1), and the view from above (Fig. 2).

"It was found that the first segmentation furrow (Fig. 3) divides each hemisphere symmetrically, and that the head of the embryo is always formed at that end of the egg (the right end in the illustrations) where the light-colored hemisphere is partly visible from above, the opposite end corresponding to the tail of the embryo. Unfertilized frogs' eggs, floating motionless on a solution of albumen, also assumed an oblique position. Hence the direction of the axis of the embryo and the position of the plane of symmetry appeared to be indicated before fertilization, but it was proved by very ingenious experiments that the oblique position first assumed is changed after fertilization, so that fertilization is required to determine the exact position of the axis. Then Roux succeeded in fertilizing the egg along an arbitrarily selected meridian, by making an incision, and thus enabling some spermatozoa to gain a headway of several minutes over the rest. This meridian always assumed a vertical position, coincident with the first furrow and the plane of symmetry. Other experiments showed that this result was due to a re-arrangement of the yolk caused by the spermatozoa, and that still greater changes could be produced by holding the egg in arbitrary inclined positions.

"The dark upper hemisphere had been assumed to correspond to the back of the frog, but Pflueger and Roux have proved that the brain and spinal cord are developed from two ridges, which originate near the right and left sides of the horizontal equator, and descend until they come together at the middle of the light-colored lower hemisphere (Fig. 7).

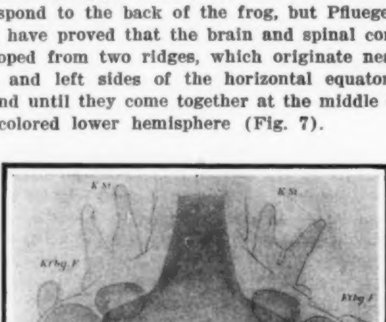


Fig. 32.—Double Head of Embryo Shown in Fig. 31

"For the purpose of determining the factors that initiate the process of cell division in the egg, Roux divided, by means of a glass rod, a circular film of oil, floating on a mixture of alcohol and water (Figs. 8 to 14). He found that nearly all arrangements of cells, or "segmentation patterns," which occur in the eggs of animals, can be imitated in this way, and that these patterns differ only in the relative sizes of their segments and the order of arrangement of large and small segments.

"Artificial diminution of some of the segments was found to produce the same result in oil drops and in living eggs, if effected soon after segmentation.

"Roux also discovered phenomena of attraction, which he called cytotropism, between detached cells of the egg. When a frog's egg which had developed numerous cells was shredded, immersed in a suitable liquid and examined with a microscope, detached cells were seen to approach each other with an intermittent motion. When several cells have come close together, the phenomena become more complex. Two cells may come together, unite closely, and then separate and form other associations. In Figs. 15 to 18, the cell 1 attaches itself to 3, then separates and forms a closer union with 5. In Figs. 19 to 24, the approach of cell 3 causes 2 to leave 1 and attach itself to the newcomer.

"As the nuclei of the spermatozoon and the ovum approach each other in a straight line from a relatively great distance inside the egg, Roux endeavored to bring about a similar result with lifeless matter. He found that drops of chloroform, floating on a saturated solution of carbolic acid, approach each other from great distances, but that this apparent attraction is caused by repulsion between the drops and the solution, and by the one-sided protection against this repulsion which each drop affords the other. (Fig. 25.)

More than twenty years ago Roux discovered that when one-half of a frog's egg in the first stage of segmentation (Fig. 3) was destroyed with a specially constructed heated needle (Fig. 26) the remaining segment could develop into a perfect right or left half, or even a front half, of an embryo. The ceiling of Roux's private laboratory is decorated with copies of these monstrosities (Figs. 27 and 28). Before this discovery it was assumed that the whole egg was required for the normal development of each part of the embryo.

"Equally surprising was the discovery that one of these half embryos can supply the missing half and develop into a complete embryo, by a process which Roux has named 'postgeneration.' Several experimenters then succeeded in producing two complete embryos by separating the two first segments of one egg by various methods, and evenly constricting with a thread an egg in an advanced stage of development (Fig. 29). Fig. 31 shows a double salamander which Spemann produced by this latter method, Fig. 32 the structure of the double head, and Fig. 30 the normal single form.

"Conversely, it has been found possible to combine two eggs to form a single embryo, and to graft two embryos together to form a double monster. The parts of these monsters developed independently until they died of inanition. (Figs. 33 to 38.) The operation succeeded even with tadpoles of two different species (Figs. 37 and 38).

"Examples of independent development of parts of

Fig. 30—The Embryo of a Normal Salamander

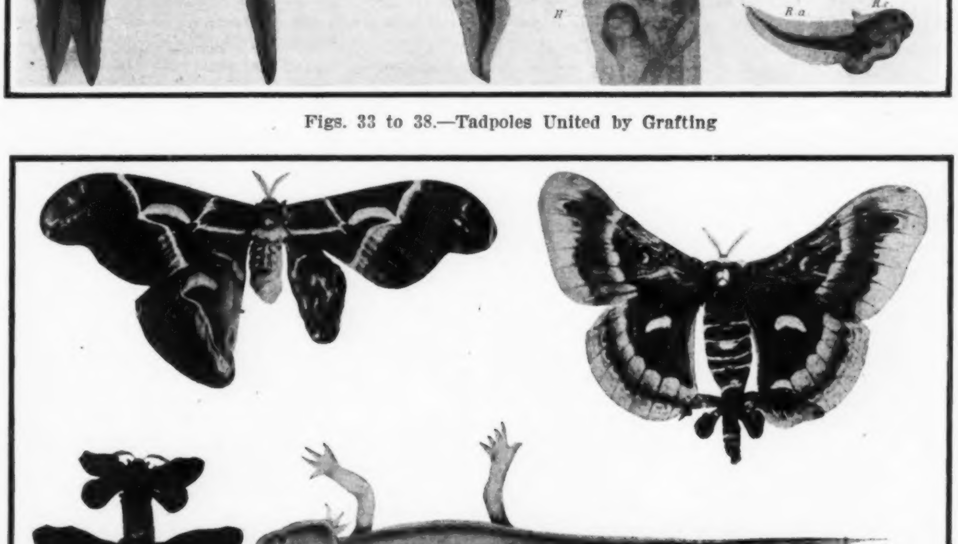
Fig. 31.—Double Embryo Produced by Constricting Salamander Egg

the embryo have been observed also in insects. The American biologist Crampton has produced monstrous butterflies of astonishing forms by combining parts of pupæ belonging to different species (Figs. 39 to 41).

"Barfurth and Lornier have produced amphibia with supernumerary toes by amputating limbs, slitting the stumps, and keeping the wounds open (Fig. 42). Double tails were produced by a similar process. The fact that an artificial division produces additional toes or tails, and not merely a cleft foot or tail, is very important in connection with the causal factors of development.

"Some of these amazing results plainly indicate that the individual is not developed according to the same fixed plan in all circumstances, but that the embryo is able to adapt its development to various conditions. For this and other reasons Roux, thirty

Figs. 33 to 38.—Tadpoles United by Grafting



Figs 39 to 41.—Grafted Butterflies

Fig. 42.—Axolotl with Supernumary Toes

Figs. 43 and 44.—"Kanga-Roux Dogs"

years ago, recognized automatic regulation of function as an essential and characteristic property of living organisms. In post-embryonal life this regulation is manifested chiefly in recovery from disease and in the functional adaptation to which allusion has already been made.

"A very interesting example of this functional adaptation was observed by Fuld, a pupil of Roux, in the case of dogs born without fore-legs, which stood and hopped in the manner of kangaroos (Figs. 43 and 44). When these dogs had attained their full growth Fuld found that their thigh bones, originally shorter than the lower leg bones, had become longer than the latter, as is the case in kangaroos. These interesting creatures have been jocularly named 'kanga-Roux dogs.' Another pupil of Roux found a similar excessive development of the thigh bone in four members of a Polynesian tribe of crouching habit.

"In conclusion, I will mention an experiment which may indirectly affect surgical practice. Prof. Kaneko of Japan, working in Roux's institute, inserted silk fibers round the bones of narcotized dogs, through and beneath the muscular attachments. The silk became covered by a sheath of cartilage, such as is normally formed over a nerve or a blood vessel which occupies a similar position relatively to a bone in the embryo. Furthermore, Levy has shown that tension can cause the formation of connective tissue along the line of stress.

"The important and surprising results obtained by Jacques Loeb, Edmond Wilson and many other workers in this new field cannot be here described. Enough has been said to show the great theoretical importance of this line of research. The art of medicine, especially in its surgical and orthopedic departments, will also gain thereby. A beginning has already been made in the 'analytical orthopedy' which was theoretically formulated by Roux twenty years ago. In this method the orthopedic capacity of every tissue involved in a malformation is deduced from experiments on animals or from the results of surgical operations, and the knowledge thus obtained is utilized in devising treatments adapted to each tissue. Furthermore, many bold and successful new surgical operations, such as the transplantation of the kidney, are based on the principles laid down in the essay on 'The Conflict of Parts in the Organism,' which Roux wrote many years ago."

# Road Making in the United States

## The Present Status of the Use of Bituminous Materials

The development of the use of bituminous materials in the construction and maintenance of roads in the United States since 1908 is worthy of careful consideration and critical analysis.

The bituminous materials which have been used in the United States during the past three years may be classified as follows: Fluxed native asphalts, oil-asphalts, residual asphaltic and semi-asphaltic oils, light oils; coke-oven tars, coal-gas tars, water-gas tars, and combinations of coal-gas and water-gas tars; combinations of asphaltic materials and tars.

The nomenclature used to designate the various kinds of tars is self explanatory. In order to avoid misunderstanding the terms used in connection with asphaltic materials will be defined, the definitions given being abstracts of those proposed by Prevost Hubbard, chemist, United States Office of Public Roads.

"Fluxed native asphalts are native asphalts fluxed with a heavy petroleum residuum. Native asphalts are solid or semi-solid native bitumens, consisting of a mixture of hydrocarbons of complex structure, free from any appreciable amount of solid paraffins, melting upon the application of heat and evidently produced by nature from petroleums containing little or no solid paraffins. Unrefined native asphalts with few exceptions contain water, vegetable matter, clay, sand, etc."

"Oil asphalts are solid or semi-solid products produced by the distillation of semi-asphaltic and asphaltic petroleums."

"Residual asphaltic and semi-asphaltic oils are heavy viscous residues produced by the evaporation or distillation of crude asphaltic and semi-asphaltic petroleums until at least all of the burning oils have been removed and often some of the heavier distillates as well."

"The term light oils includes crude and partially refined paraffin petroleums, semi-asphaltic petroleums and asphaltic petroleums.

"Paraffin petroleum is an oil the base of which is composed principally of the paraffin hydrocarbons.

"Semi-asphaltic petroleums are oils containing a semi-asphaltic base, i. e., oils whose residues produced by evaporation or distillation, while composed mainly of asphaltic hydrocarbons, contain also a certain percentage of paraffin wax."

"Asphaltic petroleums are oils containing an asphaltic base, i. e., they are capable of producing residues very similar to native asphalts if evaporated or distilled down to the consistency of such asphalts. They contain little or no solid paraffins. Native asphalts are probably produced from such oils by natural processes."

As typical of the practice in the United States will be cited the work of seven State highway departments which have used bituminous materials extensively. The writer wishes at this time publicly to thank the highway departments of the States mentioned below for their co-operation in collating the following information. The figures given refer to the total amount of work of the various types indicated which has been accomplished in 1908, 1909, and 1910 by the State highway departments of the States of Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania and Rhode Island. The work has been classified on the basis of the method employed and the kind of material used. Three general methods are referred to; namely, superficial treatment of roads constructed of ordinary macadam or gravel, the construction of bituminous pavements by penetration methods, and the construction of bituminous pavements by mixing methods. The bituminous materials employed have been classified in three groups; first, tars and tar-asphalt compounds; second, fluxed native asphalts, oil-asphalts and residual asphaltic and semi-asphaltic oils; third, light oils.

The following tables give the amount in square yards of surfaces treated and bituminous pavements constructed by the State highway departments mentioned above during the years 1908, 1909, and 1910.

Superficial Treatment of Roads.

| | Tars and Tar-asphalt Compounds. | Fluxed Native Asphalts, Oil Asphalts and Residual Asphaltic and Semi-asphaltic Oils. | Light Oils. |
|---|---|---|---|
| | Square Yards. | Square Yards. | Square Yards. |
| 1908 | 57,700 | 229,500 | .. |
| 1909 | 95,500 | 910,600 | 4,125,900 |
| 1910 | 123,400 | 2,434,200 | 9,890,400 |

Bituminous Pavements Constructed by Penetration Methods.

| | | | |
|---|---|---|---|
| 1908 | 37,800 | 25,200 | ........ |
| 1909 | 170,200 | 2,077,400 | ........ |
| 1910 | 339,300 | 4,840,200 | 26,500 |

Bituminous Pavements Constructed by Mixing Methods.

| | | | |
|---|---|---|---|
| 1908 | 52,100 | 4,400 | ....... |
| 1909 | 196,000 | 219,500 | ........ |
| 1910 | 158,000 | 492,600 | ........ |

It is interesting to note from the standpoint of the general increase in the use of bituminous materials in the States cited that in 1908 bituminous materials were employed in the construction and maintenance of 416,000 square yards of road surface, in 1909, of 7,734,000 square yards, and in 1910 of 18,244,000 square yards. Although the construction of bituminous surfaces and bituminous pavements is in its infancy in the United States, remarkable progress is being accomplished in certain sections. For instance, by the close of the construction season of 1911, if the plans of the State Highway Commission are carried out, the State of New York will have a trunk highway with a bituminous surface extending north from New York city to Albany and thence west to Buffalo aggregating over 400 miles in length.

In the surface treatment of macadam and gravel roads, several lines of development have been especially noticed: first, a more general use of refined coal gas and water gas tars in place of crude tars; second, an extraordinary increase in the various kinds of heavy asphaltic oils, combined with sand, gravel or stone chips to form a carpet wearing surface; third, an increase in the use of light oils for the purpose of allaying dust on State roads, and thus, to a certain extent, preserving the surface of the road by the retention of the top dressing; fourth, a substitution of mechanical distributors of both the pressure spray and gravity flow type in place of hand application methods.

The practice of the past three years has amply demonstrated that the success of superficial tarring is dependent upon the recognition and adoption of those fundamental principles which were laid down by the French engineers in 1903. As those principles have not been adopted in many instances in the United States, they will be given here in brief. First, superficial tarring should be done only during dry and warm weather in order to obtain efficient and economical results; second, the road must have a dry, smooth and durable surface; third, all dust must be thoroughly brushed off in order to facilitate the adherence of the tar; fourth, after the distribution of the coat of tar it is necessary, in order to avoid a slippery surface, to apply a dressing of sand, gravel or stone chips. The practice of some prominent English engineers does not include the adoption of the fourth recommendation cited, as it is maintained that a top dressing is not an essential element of a non-slippery tarred surface.

A well-developed plan of annually treating certain roads of a system with a thin coat of bituminous material is being adopted in certain States. This practice embodies the recognition of the fundamental principles of economy and efficiency in modern highway construction; namely, the adaptation of method and material to local conditions.

In connection with the use of bituminous materials by penetration methods certain noteworthy tendencies are apparent. Most important are the employment of distributing apparatus and the formation of broken stone courses in such a manner as to endeavor to secure the maximum uniformity of distribution of material and the definite limitation of penetration.

The average size of stone employed varies from ½ inch or ¾ inch in longest dimensions to 1¼ inch to 1¾ inches. In exceptional cases, however, engineers have adopted the English and French practice of using larger and more uniform sizes of stone for the top course. The unfortunate delays in the application of the penetration method due to damp stone have been overcome in some instances by the employment of mechanical surface heaters.

A modification of the penetration method is known as the "puddling method." The top course in this case is filled with screenings, puddled by watering, and thoroughly rolled. After the surface drys out it is picked up. The bituminous material is then applied, a coat of chips is spread and the surface rolled. After the surplus chips are brushed off, a flush coat of bituminous material is applied. The application of another coat of chips, and a final rolling completes the process.

Another modification of the regular penetration method has been employed during 1910. In this method the foundation is thoroughly filled and rolled. A layer of sand is spread upon the foundation course to a depth of about one inch. Refined tar heated to about 250 deg. F. is then applied to the coat of sand. The top course composed of broken stone varying from ¾ inch to 2¾ inches in diameter is spread and rolled, the lower voids being filled with the bituminous mastic. After consolidation a second coat of refined tar is applied. As soon as possible after spreading the second coat of tar a layer of stone chips is spread and rolled. A third coat of refined tar is then applied and the surface finished by rolling a covering of screenings or sand.

In the reconstruction of old roads there has been a general employment of the method of picking up the old surface to a depth of 2 inches to 4 inches by the use of mechanical scarifiers, placing a thin coat of new road metal on the loosened surface, and then constructing a bituminous pavement by the penetration method.

In both the construction and reconstruction of roads by penetration methods the surface is finished in various ways. One method is to spread a coat of chips or sand after the first coat of bituminous material is applied, roll thoroughly and after the road has set up sufficiently open it to traffic. Another method is to apply a second coat of bituminous material before the application of a layer of chips. The bituminous material for the flush coat may or may not be the same as used for the first coat. A layer of chips or sand is then spread over the flush coat and thoroughly rolled. A third method is essentially the same as the second method cited except that a layer of chips is applied to the first coat of bituminous material, thoroughly rolled and the surplus chips brushed off before the application of the flush coat of bituminous material.

From the standpoint of the character of bituminous material used it is of especial interest to note the increased use, particularly in 1909 and 1910, of fluxed natural asphalts and oil asphalts especially manufactured for application to unheated crusher run stone.

* Presented before Section D of the American Association for the Advancement of Science at the Minneapolis Meeting, December 29th, 1910, by Prof. Arthur H. Blanchard, Consulting Highway Engineer, Brown University, Providence, R. I.

In the construction of bituminous pavements by the mixing method a number of improvements and developments should be noted. Some attention has been paid to having the stone dry and reasonably clean. Although the advantages accruing by using clean and dry stone are recognized, the practice has been far from satisfactory, only very crude methods having thus far been employed. The practice of heating stone on plates has been used to a certain extent with deleterious results. In a few cases mixing machines and tar coating machines have been employed in connection with the construction of bituminous pavements which are to cost not over 90 cents to $1 per square yard. The types of the mixers which have been used to date are more or less unsatisfactory, especially when bituminous materials are used which are solid at ordinary temperatures or which flow with considerable difficulty when cold. During the season of 1911 considerable development should take place in the heating of stone by mechanical dryers, and also in the use of new types of mixers especially manufactured for the purpose of mixing bituminous materials with a mineral aggregate.

The mixing of broken stone or other aggregate with bituminous materials at a central plant and shipping the finished product by rail has not been developed to any extent in this country. The product of one company, however, has been used quite extensively in three or four States. In another case refined asphaltic petroleums have been mixed with sand and gravel, and molded into blocks at a central plant. The blocks have been laid as the wearing surface, and rolled.

Bituminous pavements constructed by mixing methods have been finished in different ways. In certain instances satisfactory results have been attained by applying a coat of chips or sand to the surface of the course of mixed aggregate and thoroughly rolling the same. In other cases a flush coat of bituminous material has been applied before the layer of mineral matter is spread over the surface. The bituminous material used for the flush coat in many bituminous pavements is not the same as was used in the mix.

In the above discussion of the mixing method it should be noted that the remarks do not in general apply to bituminous pavements constructed by mixing a carefully graded aggregate and bituminous materials, and hence do not refer to many types of bituminous pavements which have been used to a considerable extent in the construction of streets in municipalities.

In various parts of the United States sand, gravel and earth have been mixed in place by various processes with bituminous materials in the endeavor to form an impervious, dustless and durable road surface. This work is being watched with considerable interest, as the utilization of local materials for the aggregate in many instances reduces the cost of construction materially. The limitation in the weight of traffic to be carried throughout the year under all climatic conditions is one of the most important points under discussion at the present time in connection with the above methods.

A new type of construction recently introduced by Logan Waller Page, director of the United States Office of Public Roads, is known as oil-cement concrete. In this process fluid residual petroleum is added to the usual ingredients composing concrete.

From the standpoint of the nature of the material used, again it is noted that there is an increase in the use of refined tar, considerable employment of heavy asphaltic compounds and also the employment of combinations of tar and asphalt, the most noticeable increase, however, being in the use of heavy asphaltic oils which can be mixed readily with broken stone as it comes from the crusher.

There has been a marked tendency on the part of highway engineers during the past three years to appreciate more fully the importance of the various chemical and physical properties of bituminous materials. Many engineers and manufacturers now wisely advocate using different grades of the same type of bituminous material for varying local conditions and for different methods of bituminous construction. During 1909 and 1910 bituminous materials for use in the construction and maintenance of road have been purchased in two ways; namely, by buying direct from the manufacturer a product known under a trade name, and by purchasing the material under specifications. The old custom of simply purchasing bituminous material under a trade name without investigation of its properties is being replaced by the second method. The object of the second method has been to cover one or more of the following points: first, to secure uniformity in the material furnished for a given contract; second, to obtain a compound which conforms to certain requirements with reference to the chemical and physical properties of the material which are considered essential; third, to provide a standard by which it is hoped that a satisfactory material may be duplicated on other contracts. The effect of the various physical and chemical properties of bituminous materials on their value as road binders is being investigated by a special committee of the American Society of Civil Engineers. Standard methods of testing bituminous materials is the subject of investigation by a sub-committee of the American Society for Testing Materials.

In this country, as well as in Europe, considerable confusion results owing to the lack of uniformity among engineers, chemists and manufacturers relative to the nomenclature of bituminous materials. Until a recognized nomenclature is adopted it will be advisable to define methods and materials in order to avoid misinterpretation of information furnished relative to the construction and maintenance of bituminous surfaces and bituminous pavements.

# Frosting, Etching, and Coloring of Incandescent Lamps

## Hints for the Manufacturer and Amateur

In the *National Light Association Bulletin* the lamp committee of the association submits the following information as the result of inquiries from member companies and believing that it will be of general interest:

*Frosting Lamps.*—Frosted lamps improve lighting results by giving better diffusion and more agreeable lighting. A properly frosted bulb cuts off comparatively little light, averaging from three per cent to seven per cent, or from one-half to one candle-power on a sixteen-candle-power lamp.

Lamp bulbs may be superficially frosted by dipping in a compound which any company can readily purchase from various manufacturers. This frosting is not permanent, however, nor as satisfactory as the etched frost given to the lamps by the manufacturers, which is effected either by sand blast or by acid. Both processes give very similar results, but for incandescent lamps the acid method is generally used.

The acid method employs a solution consisting of hydrofluoric acid and carbonate of ammonium thoroughly mixed in a proportion of about ten quarts of acid to eight pounds of carbonate. This is contained in a leaden vat large enough for the admission of a rack full of lamps. Placed alongside the acid tub is a rinsing vat. The lamps are inserted in rubber sockets in a wooden holding rack, and after an initial dip in the rinsing vat to clean them, they are immersed in the acid solution for about half a minute, and again washed in the rinsing tub. If extra heavy frosting is required, lamps may be re-dipped as many times as necessary. Where it is required to frost only a portion of the lamp, rubber hoods are placed over the lamps to a point where the frosting is to stop. The acid frost operation is dangerous and requires considerable experience in order to obtain successful results. Utmost care must be used in handling the hydrofluoric acid compounds, as not only will severe burns result if the solution comes in contact with the human skin, but the fumes are injurious to the eyes and respiratory organs. This work should be done in a specially ventilated room, and the operator should be thoroughly protected by rubber gloves and apron.

Frosted lamps may be cleaned by dipping them in very hot water and rubbing them thoroughly dry with tissue paper. Where this is not sufficient, a little soap should be used with the hot water. Tungsten lamps should always be burning while being cleaned.

*Etching Letters or Symbols on Lamps.*—The acid etching of letters or symbols on lamps is not attended with the objections and difficulties of the complete frosting process, and can be readily employed by any company to mark its lamps permanently.

The question of identifying lamps as the company's property is a matter that has been given more or less attention—more particularly perhaps by the larger companies, in order to protect themselves against fraud and theft of lamps, especially since the advent of the metallized-filament and tungsten lamps, which are much more expensive than carbon-filament lamps.

A simple and comparatively inexpensive method, which may be used by the companies rather than by the manufacturer of lamps, is to etch the bulbs either with the name of the company, with a letter or with a symbol.

This etching is generally done on the bulb near the base, and by this means the lamp may be readily identified, as the etching is a permanent and positive mark which it is difficult to remove in any way.

It is undesirable to have the identification marks placed on lamps by the manufacturers, being necessarily expensive; and when so etched, the lamps become special and unsuitable for shipment to other than the one particular company. It is suggested, therefore, to the smaller companies, that should they meet with difficulty or loss in the theft of lamps, the following method of identification can be adopted with comparatively small attendant cost, to be used locally in their own stockroom or at any convenient point:

A rubber stamp, a solution of etching fluid and a heater with a perforated sheet-mental top are practically all the requisites necessary for this process. The heater is perforated in order that the heat may come in instant contact with the lamps and cause them to warm up quickly.

A tray full of lamps is placed in this heater with the operator on one side. In front of the operator are the stamps, a rubber pad and a small brush with which to spread the fluid on the pad. When the lamps become warm they are taken from the tray, stamped, and replaced as rapidly as possible. When they have attained a temperature of 150 deg. F., the tray is removed and the operation is finished.

The formula for the making of etching fluid is as follows:

To one pound of ammonium fluoride crystals add thirteen ounces of fifty-two per cent hydrofluoric acid and eight ounces of water. Stir this solution occasionally and let it stand over night, when it should be strained. Then strain the clear part of the solution through medium coarse muslin. Care should be taken in the selection of the ammonium fluoride crystals, which should be of fairly large size. Sheet lead or hard rubber vessels should be used as containers for the etching fluid.

*Coloring of Lamps.*—Naturally colored lamps, of which the glass is permanently colored, are the only ones that are thoroughly weatherproof. As such lamps are rather expensive, superficially colored or dipped lamps are now generally employed. Suitable coloring mixtures can be obtained from a number of manufacturers, and the lamps can be readily dipped by any operating company. In this work the old or dim lamps removed from the circuits may be used. The plan generally followed is to burn the lamp in a vertical position with tip down at about two-thirds or three-fourths of its normal candle-power. When the lamps have become slightly warm, take a cup of the dipping solution and raise it slowly until the lamp is submerged therein up to its base; then lower slowly, allowing the excess of liquid to drain off into the cup, and proceed to the next lamp. Lamps should be burned until the coating becomes thoroughly dry and firm.

Blue, green and purple are not desirable, as these colors absorb so much of the light that the lamps are hardly distinguishable at a distance.

### The Luminosity of the Sun

There have recently been published in France some stupendous figures with reference to the luminosity of the sun, as calculated by Nordmann, of the Paris Observatory.

By him the solar heat is placed at 6,482 deg. C. The sun's total candle-power is represented by him in a string of figures beginning with 18 followed by 27 noughts. This inconceivable sum is equivalent to 1,994,000 for every square inch of the sun's surface. Again, some idea of the amount of light these figures represent may be had from the fact that the most powerful electric arc light has an illuminating power of only 20,000 candles.

Prof. Nordmann states that, from every bit of the sun's surface the size of a finger nail, there issues a quantity of light that would be sufficient to illuminate the entire Avenue de l'Opéra for a whole night. Inasmuch as the sun's surface is estimated to be some 200,000,000 square miles, its total luminosity may be placed at 51,000,000,000,000 times that of the street mentioned.

This French observer has also undertaken the task of measuring the light and heat of various large stars, some of which are stated to be even more powerful illuminants than the sun. For example, Sirius is found by him to be about thirty times hotter than the sun, i. e., 190,600 deg. C., while the Polar Star is a comparatively cold body of merely 8,200 degrees.

# Psychanalysis

## Getting at the Facts of Mental Life

### A New Field of Research

Psychanalysis is a new word, which, in terms comprehensible to the lay mind, has been defined, says *Science and Discovery*, as the science of reading the inmost secrets of the heart and soul in spite of—sometimes without the least suspicion on the part of—the person who is the subject of investigation. The word psychanalysis has been much used in the medical and psychological organs of late with reference to the remarkable discoveries in pathology of mental ills by the distinguished Dr. Freud of Vienna. But the practical application of psychanalysis as a means of getting at the facts of mental life is most indebted to Dr. Jung, the famed specialist in psychological therapeutics whose cures are making a sensation in Germany. It has been said of him in the London *Lancet* that his cases read like reports from a new psychological world. The fullest account of the Jung method is given by the able associate in psychiatry at Columbia University, Dr. E. W. Scripture. There are three methods of getting at the facts of mental life, explains Dr. Scripture. The first is that of simple observation. This leads to treatment by the physician by the usual medical procedure. The second method of getting at the facts of mental life is by that of experimental psychology. Its aim is a most careful and accurate analysis of a patient's mental condition by tests and records. This has been much exploited in lay and technical publications in late years. The third method—involving medical reports from a quiet new psychological world—is that of psychanalysis.

To take up Dr. Scripture's exposition, suppose a patient presents himself with a paresis of the right arm which began years ago. There is not the slightest symptom of anything organically wrong. It is evidently a hysterical paralysis. Or suppose a man appears complaining that he is tortured beyond endurance by a fear that he can not perspire. He never has the slightest difficulty and he knows the fear to be foolish. Yet this fear is so constant and overpowering that he has been obliged to give up work. Again a patient comes to the office saying that for years he has been tortured by a fear of touching filth. He washes his hands a hundred times a day.

Such cases are beyond the methods of observation. In our own mental life there is nothing like such conditions. They are so far beyond our understanding that they seem weird or incomprehensible. The patient with the fear of filth told Dr. Scripture that he knew it to be nonsensical and that he spent hours in discussing it with himself. It is one of the greatest feats of the method of phychanalysis that it has found the mental mechanism of such cases.

To analyze a case of the sort, recourse is had by Dr. Jung to his co-called association method. In this a word is spoken and the patient is required to say at once what he first thought of. The time taken is measured with a stop-watch. After a hundred such associations the patient is required to tell again what he thought of in each case. Whenever the time of association is unusually long, when there is evidence of forgetfulness, when the patient does not respond at all to the word called out, when his association is superficial—in short whenever the association is of unusual character—the word called out touched upon some topic on which the person was highly sensitive. A sensitive topic in one case was an experience on the water and a record of it works out in this style:

| Word Spoken. | Association. | Time. | Memory. | Sensitive Topi or Comple-. |
|---|---|---|---|---|
| head | hair | 1.4 | x | |
| green | meadow | 1.6 | x | |
| water | deep | 5.0 | swim | ! |
| stick | knife | 1.6 | x | |
| long | table | 1.2 | x | |
| ship | sink | 3.4 | steamer | ! |
| ask | answer | 1.6 | x | |
| wool | knit | 1.6 | x | |
| obstinate | friendly | 1.4 | x | |
| lake | water | 4.0 | blue | ! |
| sick | well | 1.8 | x | |
| ink | black | 1.2 | x | |
| swim | can | 3.8 | water | ! |

Applied to the man with the paretic arm the association tests showed that the words in the list where the most disturbance occurred (long time, forgetfulness) were "proud," "pure," "arm," "bird," "death," "sin." The words he thought of as associations most frequently were "love," and "like," 8 times; "not," 6; "I," ; "marriage," 3; "arm," 3; "lake," 3. Now just try to put these words together as a picture of his mental condition. "I am (or was) proud that I am (or was) pure. I have sinned. I would prefer death. I do not love my wife (marriage)." The words "arm," "bird," "lake" remain unexplained. Nevertheless a moral catastrophe is revealed.

This will be more evident to the lay mind from another case—that of a happily married woman subject to explosions of jealousy with outbreaks of violence and of running away from the house. These outbreaks she carefully concealed from the rest of the family. She wreaked her temper on her husband, who was a model man. In the association tests the strongest disturbances occurred with the words "happiness," "anxiety," "religion," "choose," "marry," "part," "death," "die." In her associations she uses "like" 13 times, "man," 10; "child," 7; "necessary," 7; "beautiful," 6; "I," 4.

It was possible to guess the story from these results alone, but it was easier to confront her with the record and show her conclusively that she has revealed something compromising to her happiness, that she is anxious about something, that religious questions are troubling her. The patient owned up that she was not happy with her husband, that she is anxious about the future and does not know what to do, that she is married outside of her religion and to a man whom she chose against the wishes of her parents, and that she is debating whether she shall part with him or die.

Another method of phychanalysis is that of running associations. This was introduced by Freud:

"The patient is told to let his mind wander with perfect freedom and to tell his thoughts as they arise. The method is useful in the most varied ways. It must first be made clear to the patient that his cure depends upon telling the truth; no matter how private may be the thought that arises, he must tell it frankly to the physician.

"This method I will illustrate by the case reported by a clergyman of Zurich. He noticed in a composition written by one of his pupils, a boy of eleven years, indications of strained relations among the members of the family. Knowing that he could not possibly get the facts otherwise, he applied a combination of the association experiment with running associations. For example, the word 'water' aroused the association 'corpse' after four seconds. Thereafter the boy associated 'ship,' a 'drowned person,' 'I saw how a drowned person was taken into a boat.' 'Now tell all the words that occur to you,' said the clergyman. 'Bathe, swimming, bathhouse, bottom, seaweed, shark, earth, stone, springboard, air, chain, beam, submarine boat, screw, no air, drowned.' 'What occurs to you now?' asked the clergyman. 'I saw some moving pictures with two divers that found gold. One cut the air tube of the other, took the gold, and went up.' The word 'diver' brought up the association of 'the dead diver in the moving pictures. We could see his pale face. We once got a wax mask representing a dying king with eyes turned up. Arno (his brother) put on the mask and wrapped a shroud around him. He looked like a ghost. I was frightened. The dying diver reminds me of this wax figure (meaning his brother in the mask).' Over and over again the boy produces series of associations ending up in some representations of his brother as dead, as in prison, as tortured, as murdered by himself, as crucified, etc. It was very evident that he hated his brother from the bottom of his soul. This he did not realize in the least himself. The information and the treatment came through this method of psychanalysis.

"The method of running association is based on certain laws of the association of ideas. One of these we may state as follows: The oftener an idea or an element of an idea has been in mind the more frequently it will appear in associations. The brother Arno was constantly in little Max's mind; no matter what he started to think about, the thought of Arno would sooner or later appear. Another law is that the intenser an idea is or the more motion it arouses the more often it recurs. A person will remember the time he made a fool of himself, no matter how much he wishes to forget it. Start any one on memory associations, and he will inevitably land over and over again on the chief topics in his mind and will involuntarily deliver his secrets over to you.

"The more the running association is freed from the control the better the information concerning the person's mind. Seat yourself in quiet and let your mind wander in associations. You will notice that at each step a dozen new things crowd in together. Instinctively you pick out one and proceed. For example, with the word 'lamp' there appear at once to my mind in half-formed condition a certain gas flame, a certain electric light, a certain proverb, etc.; one of these I have to catch because I cannot think clearly of all of them at the same time. I catch the certain electric lamp. It is in a certain room; this leads my thoughts in that direction. If I had caught the gas flame, my thoughts would have gone otherwise."

From childhood up we have been trained to control our thoughts, to proceed in an orderly fashion, to speak only in a modest way, even to think in a modest way. This control becomes automatic. When we let the thoughts wander, we automatically catch only those thoughts that fit our training. In the presence of another person we are trained to speak only in a discreet manner; even to think otherwise is not proper. Automatically we catch only the discreet thoughts and suppress the others. In the doctor's office the conversation is freer, but even here it usually requires some training before the patient can let himself think freely.

Another method is that of assigning a topic concerning which all impromptu thoughts are to be noted down. For example, the physician tells the patient to note down on the spot each thought that arises impromptu concerning himself (the physician). Thus a patient reports that in an entirely impromptu manner the thought occurred to him that the doctor was getting bald. On another occasion he said he thought the doctor was getting stout, and so on. An entire group of these observations revolved around the signs of advancing age. This was in fact the great trouble of the patient. He felt that he was getting old. This line of psychanalysis lets a flood of light in upon the dark places of the human soul and heart:

"Another patient reports that the thought had occurred to him that the doctor was extremely considerate of the feelings of his patients, that he was really rather bashful, and so on. This simply reflected the patient's condition of bashfulness and overanxiety about how people felt toward him. Still another patient thought that the doctor must make a great deal of money out of his practice, that he dressed in expensive clothes, etc. Of course, the inference was at once clear, namely, that the patient's thoughts centered around money. I have never had an experience quite like one that Dr. Jung related to me. One of his patients, a clergyman, told him that the thought had occurred that Dr. Jung was not strictly truthful, that he was not quite honorable in dealing with his patients, that he did not believe that he led a strictly moral life, etc. Before knowing the facts of the case Dr. Jung replied, 'It is *you* who are the liar, *you* have not acted honorably with your parishioners; *you* are doing something immoral.' The thoughts that arise impromptu like this are always reflections of the patient's own personality."

Nor has this new method of psychanalysis produced results less remarkable in the interpretation of dreams. It seems that the dream is in reality a clue to the mental and even the physical life of far greater importance than any scientist has ever suspected or been disposed to admit. For the man who tells what he has dreamed the night before is revealing, did he but know it, the inmost secret of his whole life.

**Enlarging a Baltic Seaport.**—A project for extensive engineering work for the purpose of enlarging the port of Dantzig was discussed at a recent meeting of municipal and commercial representatives of that city. The matter bore upon increasing the size of the port at Neufahrwasser, and the canal of the port would thus be enlarged considerably so as to reach a width of some 300 feet. The outlay which is needed for this work is estimated at $500,000, to be borne two-thirds by the State, and the remainder to be divided among the naval docks, the municipality and the commercial interests of the city.

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